Digitized by the Internet Archive
in 2008 with funding from
Microsoft Corporation

http://www.archive.org/details/chemicalgazetteo4142londuoft

THE

CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE.

WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE."

A Journal of Practical Chemistry

IN ALL ITS APPLICATIONS TO

PHARMACY, ARTS, AND MANUFACTURES.

EDITED BY

WILLIAM CROOKES, F.R.S., &c.

VOLUME XLI.—1880.

47804
27 | 3 | 00

LONDON:
PUBLISHED AT THE OFFICE, BOY COURT, LUDGATE HILL, E.C.
AND SOLD BY ALL BOOKSELLERS.

MDCCCLXXX.

LONDON

PRINTED BY EDWIN JOHN DAVEY,

BOY COURT, LUDGATE HILL, E.C.

THE CHEMICAL NEWS.

VOLUME XLI.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1049.—JANUARY 2, 1880.

ON A NEW HYDRIDE OF SILICIUM.

By M. J. OGIER.

1. I HAVE submitted pure siliciuretted hydrogen to the action of the electric effluvium.* After a sufficient time this gas is entirely destroyed ; a yellow coating is formed in the interior of the tubes, and the volume of the gas increases up to an apparently constant limit.

2. The residual gas does not contain a trace of silicium, but it is simply pure hydrogen.

The ratios between the volumes of the siliciuretted hydrogen used, and the hydrogen resulting from its decomposition, have been found in five different experiments to be :—

$$\frac{1}{1{\cdot}21}, \quad \frac{1}{1{\cdot}22}, \quad \frac{1}{1{\cdot}21}, \quad \frac{1}{1{\cdot}29}, \quad \frac{1}{1{\cdot}26}.$$

From these results it is easy to find the composition of the solid which was left on the glass, which contains the remainder of the hydrogen, united with all the silicium. In this way we arrive at the following formulæ (Si = 28) :—

$$SiH^{1{\cdot}58}, \quad SiH^{1{\cdot}56}, \quad SiH^{1{\cdot}58}, \quad SiH^{1{\cdot}42}, \quad SiH^{1{\cdot}48}.$$

These figures answer very nearly to the composition of Si_2H_3. The body under examination will, therefore, be a subhydride of silicium, corresponding to the suboxide of carbon, or again to crotonylene, in the series of carburetted gases.

3. Some of the properties of this body are as follows :—When moderately heated in air it burns, throwing off small sparks. The combustion takes place spontaneously when hit with a hard body, or when rubbed with a steel blade. This subhydride is inflammable in chlorine when cold. When heated cautiously in an atmosphere of hydrogen or nitrogen, it evolves siliciuretted hydrogen, easily recognised by its spontaneous inflammation in the air ; a higher temperature only causes a deposit of silicium with the evolution of hydrogen.

4. We have seen that the electric effluvium at a high tension produces effects on siliciuretted hydrogen, analogous to those which it produces on formene (the formation of acetylene, and a condensed carbide having a smell like turpentine, according to M. Berthelot). The analogy rests, if we study the fixation of nitrogen, by the effluvium on the siliciuretted gas. In fact, a mixture of equal volumes of nitrogen and siliciuretted hydrogen gave after the action of the effluvium a residual gas, consisting of hydrogen, nitrogen, and ammonia, which latter was easily detected by means of hydrochloric acid ; but the ammonia was present in a very minute quantity, in fact it was hardly 1 per cent. of the residue.

On the other hand, the solid matter had equally absorbed a small quantity of nitrogen, which was evolved as ammonia by means of melting potash. This is exactly what was observed when the mixture of formene and nitrogen was submitted to the action of the electric effluvium.

5. I have experimented to see if any analogous hydride would be produced when siliciuretted hydrogen is carefully heated. This gas is almost as stable as the corresponding carbides of hydrogen, for it will stand a temperature of nearly 400° before beginning to decompose. Keeping it at this temperature, I observed after a quarter of an hour a decomposition of more than 10 per cent. ; after an hour the destruction was almost complete. Thus the siliciuretted hydrogen resolves itself, purely and simply, into silicium and hydrogen without forming any intermediate hydrides as the carbides of hydrogen do.

6. I have similarly studied the action of the effluvium on arseniuretted hydrogen ; it also forms a solid hydride As_2H, corresponding to the solid phosphide of hydrogen, P_2H.*—*Comptes Rendus*, Dec. 22, 1879.

* In the pipettes described by M. Berthelot (*Annales de Chimie et de Physique*, 5th series, vol. x., p. 76), in which the gas can be very easily introduced, taken out, and measured over mercury.

ANSWER TO THE NOTE BY DR. PHIPSON CALLED "NEW AND OLD VIEWS ON THE NASCENT STATE OF BODIES."

By Dr. TOMMASI.

IN the note by Dr. Phipson there are three points on which I should like to make some observations :—

1. Dr. Phipson says :—Many chemists will doubtless have been misled by the title of Dr. Tommasi's first note, "On the Non-Existence of Nascent Hydrogen," but it appears by his second note that he admits its existence, for he says :—"The reductive power, &c. . . . . So that the author not only does *not* deny the existence of nascent hydrogen, but actually supports it by a theory of his own."

* This research was carried on in M. Berthelot's laboratory at the Collège de France.

I will remind Dr. Phipson that since I have occupied myself with the question of nascent hydrogen, I have always been convinced that hydrogen is much more active at the moment of liberation than when in the ordinary state; and the only aim of the experiments that I have done on this subject has been to find out the cause of this singular anomaly.

Dr. Phipson is therefore in error when he thinks that I contradict myself, because, after having denied the existence of nascent hydrogen (as being a state peculiar to this gas), I gave an explanation of it later on. Dr. Phipson's observation arises no doubt from a misunderstanding; therefore, I shall not press this point any further.

2. According to Dr. Phipson, my theory on nascent hydrogen is nothing more than a reproduction of the theory that he started in 1855, with this difference only, that in the place of "electricity" I have employed the word "caloric."

It is possible that Dr. Phipson is right, but it seems to me that he ought to have the kindness to prove it.

Why does he not bring forward some of the passages from his pamphlet on "Nascent Hydrogen?" Why does he not make known the experiments that he has made on this subject? Finally, why does he not give the definition of nascent hydrogen as it is, without doubt, in the pamphlet?

M. Berthelot also not long ago,* pretended that he was the first to give a rational theory on the nascent state of hydrogen, and it is in the following terms that he does so.

"All this (reductions produced by alkaline amalgams), enters into the general theory of the reactions attributed formerly to the nascent state, reactions of which I exposed the real interpretation in 1865, during my lectures at the 'College de France' (published by the *Revue des Cours Publics*, and partially reproduced in the *Annales de Chemie et de Physique*, 4th series, vol. xviii., pp. 61, 66, 15 and thereabouts Sept., 1869)." But if you open these two volumes, you will not be able to find a single sentence which makes one even suspect why nascent hydrogen is more active than ordinary hydrogen. That, however, does not stop M. Berthelot from being altogether as convinced as Dr. Phipson that he was the first to explain the nascent state of hydrogen. I will even venture to say, that to give an explanation of the action of the reduction of alkaline amalgams, M. Berthelot has been obliged to have recourse to my thermic theory, and to avail himself of my own expressions.

3. After having addressed flattering words to me, for which I thank him greatly, Dr. Phipson proceeds in this manner; "Dr. Tommasi will be the last person not to see the identity of the reduction of auric chloride by hydrogen gas *in presence of platinum*, for instance, with the phenomena of hydrogen in the nascent state.

By a lucky chance Dr. Phipson has not made a mistake in saying that, for it is precisely the following that one sees in my first pamphlet on nascent hydrogen.

"According to the researches of M. Becquerel it follows that whereas hydrogen does not reduce a solution of chloride of gold, it acquires this property when the solution is in contact with a platinum wire, of which one end is plunged in the liquid and the other in the gas; the gold is precipitated in a metallic state on the part of the wire which is in the liquid, and the gas is absorbed according as the deposit is affected. M. Becquerel explains these reductions by the action that the presence of platinum would give rise to. As for us, we think that the reduction of the chloride of gold by means of hydrogen and platinum is due to the heat disengaged during the condensation of the hydrogen on the platinum." (*Rendiconti del R. Istituto Lombardo*, serie ii., vol. x., fasc. xv., p. 6. 1877.)

Solubility of Benzoic and Salicylic Acids.—E. Bourgoin.—At 0° 1 part of benzoic acid requires for solution 588 parts of water and 1 part of salicylic acid, 666 parts.—*Journal de Pharmacie et de Chimie.*

* *Journal de Pharmacie et de Chemie*, Août, 1879, p. 132.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from vol. xl., page 304.)

THE remarkable researches of Roscoe, on vanadium, have shown the quantitative, and also in many cases the qualitative (such as in the oxychloride), analogy of this element with phosphorus. The position that vanadium holds in the system is expressed by the following proportions which, I think, do not need further explanation:—

(1.) V : P = Nb : As, or V : As = Nb : Sb = Ta : Bi;
(2.) V : P = Ti : Si = Cr : S;
(3.) V : Cr : Ti = Nb : Mo : Zr.

It is seen from these proportions that the true atomatologues of V are, on the one hand, Ti and Cr, and on the other hand, Nb and Ta, with which it shows more analogy than with P: in the same way Cr is more nearly related to Mo and to W than it is to S. The corresponding compounds of Ti, Cr, and V resemble one another in their reactions, their properties, and even in their aspect. The yellow colour of the acid salts of chromium are very similar to many of the acid salts of vanadium: the green colour of the salts of sesquioxide of vanadium reminds us of the green colour of the salts of sesquioxide of chromium. The distribution of V in nature corresponds with that of Ti and of Cr. The analogy which exists between the oxychlorides $VOCl_3$ and $POCl_3$ has for a companion the analogy between CrO_2Cl_2 and SO_2Cl_2. Further, this circumstance corresponds with the interesting case of isomorphism that Marignac has noticed between R_2TiF_6, R_2NbOF_5, and $R_2WO_2F_4$.*

We know that the most different opinions have been expressed relative to the position that *thallium* holds in the system until its properties were fully known. According to the periodic law this element is placed in the eleventh series, between Au = 197 and Hg = 200 on the one hand, and Pb = 207 and Bi = 208 on the other. The nature of its highest oxide, Tl_2O_3, gives it at the same time a place in the third group, near Al = 27 (and In = 113, as we shall see in the following chapter). This place corresponds to all the properties of Tl, although at first sight it gives rise to doubts, the oxide of thallium, Tl_2O_3, showing very little analogy with alumina. However, the proportion—

Tl : Al = Hg : Mg = Pb : Si,

carries sufficient conviction that such is the natural position of thallium.

It is only the highest oxide of Hg—that is, HgO—which shows any analogy with MgO; PbO_2, the highest oxide of Pb, only shows any analogy with SiO_2. In the same manner, Tl only shows any analogy with Al in its highest oxide, Tl_2O_3. HgO and MgO are bases which give salts, such as RX_2; Tl_2O_3 and Al_2O_3 are less energetic bases which give neutral and basic salts such as RX_3; PbO_2 and SiO_2, on the contrary, are but feebly acid oxides. Oxide of thallium is relatively to acids a more energetic base than Al_2O_3, exactly as HgO takes the place of MgO. If Tl gave, independently of Tl_2O_3, a highly basic suboxide, Tl_2O, of which Al is not capable, Hg would give Hg_2O independently of HgO, whilst for Mg we only know of one form of oxide. Pb, differently to Si, gives independently of PbO_2 a highly basic oxide, PbO.

The higher oxides HgO, Tl_2O_3, PbO_2, Bi_2O_5 are peroxides, relatively to the lower forms, Hg_2O, Tl_2O, PbO, Bi_2O_3. If in Bi_2O_3 the basic properties are more feebly expressed than in PbO, Tl_2O, that is explained by the more strongly acid properties of Bi_2O_5, relatively to Tl_2O_3 and to HgO. If Tl_2O in the salts corresponds in part to

* We can consider $R_2MnO_3F_2$ and $R_2OsO_4F_2$ as the continuation of this series, although it is rather doubtful. (See Marignac *Bibliothèque Universelle de Genève*, t. xxiii.; *Annales de Chimie et de Physique* [3], t. lxix.)

X_2O, we can also find an analogy between PbO, in the salts PbX_2, and CaO, as well as between Bi_2O_3, in the salts BiX_3, and the elements of the third group, which give salts such as RX_3. The highest oxides, HgO, Tl_2O_3, PbO_2, and Bi_2O_5, are coloured powders; they can be reduced to lower oxides, and when calcined they give off oxygen; mercury forms a stable perchloride, $HgCl_2$, corresponding to the maximum of oxidation; perchloride of thallium has been prepared ($TlCl_3$, or apparently Tl_2Cl_6), but it is easily decomposed by heat with the evolution of chlorine, and the lower form of combination, TlCl, is formed. This explains why lead and bismuth do not furnish us with compounds, as $PbCl_4$ and $BiCl_5$, but give stable bodies, $PbCl_2$ and $BiCl_3$. $BiCl_3$ is easily decomposed by water; $PbCl_2$ is only decomposed by steam when red hot; TlCl is stable. Thallium is less volatile than mercury, and more so than Bi or Pb. All the properties that I have mentioned are shown by the following proportions:—

(1.) Tl : Hg : Pb = Al : Mg : Si;
(2.) Tl : K = Pb = Ca;
(3.) Tl : Hg = Pb : Tl = Bi : Pb.'

It should not be forgotten that these relations are not arbitrary; that they not only express the relation of the properties, but also that of the atomic weights. Thus the proportion—

Tl : Hg : Pb = Al : Mg : Si.

is represented by the members—

204 : 200 : 208 = 27 : 24 : 28.

If, instead of the sign (:) of geometric proportion, we put the sign (−) used in arithmetic proportion, we get in reality—

204 − 200 − 207 = 27 − 24 − 28.

However, we must remember, first, that we do not know exactly the real value of atomic weights; and, secondly, it is necessary to observe that we are unable to wait for completely exact relationships, because the true function, expressing how the properties depend on the atomic weights, is unknown to us.

Further, it is certain that the elements possess, independent of the primary properties which determine the analogy and the position of elements in the system, certain individual properties. When the above-mentioned function has to be found exactly, these properties will be explained without doubt by the irregularities in the variations of the atomic weights, irregularities which now appear to be inexplicable.

We can also foresee in the atomic law a kind of perturbation, which cannot cause us to suspect the exactness of the law. The transition of HgO to Hg_2O, and of Tl_2O_3 to Tl_2O, is in the example quoted. A disturbance of this kind for the higher oxides would keep the suboxides of unequal composition subordinate. These suboxides are, among themselves, in the same relation as Cu_2O or Ag_2O is to K_2O or to Na_2O. The suboxide of mercury is, in many respects, analogous to oxide of silver; as suboxide of thallium is analogous to oxide of potassium. However, the salts HgX and TlX concord more between themselves and with AgX than AgX and KX do. These phenomena are already very complicated, and if I mention them here it is only to call attention to the problems raised by the application of the periodic law to the system of elements. The periodic law, I think, should not be neglected when chemistry becomes more elaborated, although it has, I well know, need of development.

I will add still another remark: it is that the use of the periodic law facilitates the learning of chemical facts by beginners. I have come to this conclusion during the courses of lectures that I have given for two years, and during the preparation of my "Traité de Chemie Inorganic," now published (in Russian), which treatise is based on the periodic law.

(To be continued.)

EXPERIMENTS ON THE CONTAMINATION OF ATMOSPHERIC AIR WITH THE VAPOURS ARISING FROM ARSENICAL PIGMENTS.*

By WILLIAM FOSTER, M.A. (Cantab.), F.C.S., &c., Lecturer on Chemistry at the Middlesex Hospital.

LIKE others similarly circumstanced to myself, I am frequently called upon to examine fabrics and domestic materials for arsenicum. An ordinary but marked case came under my notice about two and a half years ago, some particulars of which are given in the *Lancet* of the 11th August, 1877. The circumstances were briefly as follows:—A family had suffered from illness: the symptoms described were those which follow the administration of arsenicum. Samples of the chintz curtains and linings used in certain rooms were sent me for examination, and were found to contain large quantities of the element in the condition of an arsenate of chromium and iron. I estimated the amount of arsenicum in the chintz and the lining, and, having been furnished with the numbers representing the quantity of the two materials used in one of the bed-rooms, I calculated the total amount of arsenicum present. Considering the element as white arsenic, there was as much in this one bed-room as would furnish 26 ounces of white arsenic.

The mischief arising from the presence of these excessive quantities of arsenicum in the green colouring-matter of these chintz curtains was believed, and stated at the time, to be due to the dissemination of fine particles of the colouring-matter in the atmosphere of the apartment, and I am not in possession of any information which would lead me to alter my belief. However, the possibility of arsenicum assuming the vapourous condition in this and similar instances was forcibly brought before me at that time. Since then one occasion has presented itself where an arsenical paint was believed to be the origin of much mischief. In such cases the most feasible explanation of the effects of such paints is that which attributes the action of the poison to some volatile compound of arsenicum. This belief is somewhat widely spread, and has been strengthened by more than one speaker at meetings of this Society, when the subject of arsenical pigments has been under discussion. The arsenicum in these instances is believed to slowly take the form of gaseous arseniuretted hydrogen. During the early part of this year I therefore commenced some experiments on an arsenical pigment, and I selected Scheele's green, in consequence of its being one of the best known and most extensively used of the pigments containing arsenicum as an essential constituent.

The two questions I proposed for experimental investigation were—

1. Does Scheele's green, at any ordinary temperature, give off white arsenic when the pigment is subjected to a current of air?
2. Does Scheele's green, mixed with linseed oil and turpentine, as in ordinary paint, and spread over a large surface, give off arseniuretted hydrogen when a current of air is passed over it?

The first set of experiments were of the following character:—A bottle of about a pint capacity was fitted with an india-rubber plug having two perforations. A piece of glass tubing passed through one of the holes, and nearly reached the bottom of the bottle. A second piece of glass tubing just passed through the second hole in the plug, and at its anterior extremity was connected by means of flexible tubing with a U-shaped bulb tube containing a solution of caustic potash for the absorption of the white arsenic, should any be eliminated. The U-tube was further connected, by means of flexible tubing, with an aspirator, which was kept working regularly and continuously for several days together. The bottle containing the

* Paper read before the Medical Society, December 15th, 1879.

pigment was first filled with clean and large fragments of broken glass, and then a quantity of the dry Scheele's green was added, the whole being afterwards thoroughly shaken, so that the surfaces of the pieces of broken glass should be thoroughly dusted with the pigment. The outlet tube from the bottle containing the pigment, and in connection with the caustic potash bulb tube, was loosely but carefully plugged with cotton-wool, so that the current of air passing through the arrangement could not carry away any of the pigment mechanically. Further, the bottle containing the Scheele's green was placed in a water oven heated by a gas flame. The temperature of the oven was not by any means very uniform, but still always much higher than that of the atmosphere at the time. I have not used a pressure regulator for the gas supply; hence the temperature of the oven would be higher during the evening than any other period in the twenty-four hours. During the day the temperature of the water oven was usually 45° to 50° C.

The experiments therefore consisted in passing a continuous stream of atmospheric air over a largely-extended surface of Scheele's green, which was kept at a temperature of about 50° C., filtering the air by means of cotton-wool, and then causing it to pass through caustic potash solution. The current of air was regular and continuous in every experiment. One experiment extended over a day, two over two days, and a fourth over seven days. In each of the experiments the potash solution was treated with excess of pure sulphuric acid, and then examined for arsenicum by means of Marsh's apparatus. In each and all of the experiments I could not obtain the faintest indication of the presence of arsenicum.

The second set of experiments were made as follows:—A bottle, having the capacity of nearly 4 pints, was furnished with a well-fitting cork, having two tubes passing through it, and arranged as in the foregoing instance. In this case it was not deemed necessary to filter the air. The bottle containing the paint was in connection with two U-tubes arranged in series, and the extreme one in turn connected with an aspirator as before. One of the bulb tubes contained a solution of caustic potash, and the other a solution of nitrate of silver. A quantity of this paint was first made by mixing Scheele's green, turpentine, and linseed oil. Thin deal shavings were then smeared with the paint, and the bottle was filled and securely corked. The whole arrangement of paint bottle, bulb tubes, and aspirator, was then connected and put in working. The air leaving the bottle was first worked with the potash solution, and afterwards by the silver nitrate solution. The bottle containing the paint was heated in one experiment only. Ordinarily the temperature of the air was about 14° C. Two experiments extended over five days, two over six days, and one over nine days. In the last of these five experiments the paint bottle was placed in a water-bath, and continuously heated without noting the temperature of the bath, because the paint bottle was but partially immersed in the water of the bath. In each of the experiments the potash solution was removed from the bulb tube, made acid by means of sulphuric acid, and then tested by means of Marsh's apparatus. Not the slightest trace of arsenicum could be detected in any instance. The silver nitrate solution was also removed and diluted with distilled water, hydrochloric acid being afterwards added in slight excess. The whole of the precipitated silver chloride was then removed by filtration; the filtrate was warmed, charged with sulphuretted hydrogen, and allowed to stand for at least twelve hours. The turbidity produced was so exceedingly slight that I conclude arsenicum was entirely absent. It would have been almost impossible to deal with the minute quantity of precipitate causing the turbidity. However, as a precaution, the very faintly turbid solution was evaporated to a small bulk in a porcelain dish, and then examined by means of Marsh's apparatus. Not the slightest indication of arsenicum was obtained in any of the experiments.

From the experiments I do not get the slightest evidence capable of furnishing an affirmative answer to either of the questions I proposed at the beginning of these experiments. However, I should very much like to see the experiments on arsenical paints carried out on a much larger scale, in chambers or vessels which would admit of the whole of the apparatus being enclosed and uniformly heated.

I may mention that, in the wet paint experiments, the potash solution was always to have absorbed a considerable quantity of what was, presumably, oxidation products of the oil and turpentine. I partially examined a little in one of the experiments, and obtained an abundant reaction characteristic of acetic acid. Other substances were also present. I cannot help thinking that some of the bad effects attributed to arsenical paints are much more likely to be due to the volatile oxidation products of the linseed oil and turpentine than to the arsenicum present in the original paint, and if we knew more of their nature the whole question would be much simpler.

In conclusion, I have to thank Mr. Henry Carr, C.E., for his courtesy and kindness in furnishing me with a considerable amount of literature and information on the subject of arsenical pigments. A very large portion of this literature is descriptions of medical cases where the symptoms of arsenical poisoning have been very marked, and the writers have expressed their belief that the mischief has been caused by the inhalation of fine particles of arsenical dust. My experiments have no reference whatever to this aspect of the question, and I wish it to be distinctly understood that I most strongly deprecate the use of arsenical pigments, in consequence of the mischief which may arise from their dust, although I have not been able to show by these experiments that they give off the vapours of white arsenic or arseniuretted hydrogen.

THE SUPPOSED ARTIFICIAL PRODUCTION OF THE DIAMOND.

The following letter from Professor N. S. Maskelyne, F.R.S., appeared in *The Times* of Wednesday, December 31st, under the above heading.

"Sir,—I should be obliged if you would accord me space in *The Times* in order that I may answer a great number of letters and applications which have pursued me during the past few days on a subject of some little public interest, that subject being the asserted formation of diamonds by a gentleman at Glasgow.

Some ten days ago I had heard nothing whatever of the claim of Mr. Mactear, of the St. Rollox Works, Glasgow, to the artificial production of the diamond. My name, however, was already in several newspapers as that of a person in whose hands the asserted diamonds had been placed for a decision as to their true nature. Ultimately a small watch-glass, with a few microscopic crystalline particles, came into my hands for this purpose from Mr. Warington Smyth, and subsequently a supply came to me direct from Mr. Mactear. I shall proceed to state the results I have obtained from the examination of these.

Out of the first supply I selected by far the largest particle, one about 1-50th of an inch in length, and it may be that I wasted some time in experimenting on this particle, as it might not have been an authentic example of the "manufactured diamond," since it differed in some respects from the specimens I have since received direct from Mr. Mactear.

Now, firstly, the diamond excels all substances in hardness Secondly, its crystals belong to the cubic system, and should not, therefore, present the property of doubly refracting light. Frequently, however, from the influence of strain within the crystal, caused by enclosed gas-bubbles or other causes, diamonds are not entirely without action

on a ray of polarised light sent through them. Finally, the diamond is pure carbon, and, as such, burns entirely away when heated to a sufficiently high temperature in the air, and more vividly so burns or glows away when heated in oxygen gas.

The specimens I had to experiment upon were too light to possess appreciable weight, too small even to see unless by very good eyesight or with a lens, yet were, nevertheless, sufficiently large to answer the three questions suggested by the above properties.

A few grains of the dust, for such the substance must be termed, was placed between a plate of topaz—a cleavage face, with its fine natural polish—and a polished surface of sapphire, and the two surfaces were carefully "worked" over each other, with a view to the production of lines of abrasion from the particles between them. There was no abrasion. Ultimately the particles became bruised into a powder, but without scratching even the topaz. They are not diamond.

Secondly, some particles, more crystalline in appearance than the rest, were mounted on a glass microscope slide, and examined in the microscope with polarised light. They acted each and all powerfully in the manner of a birefringent crystal. It seemed even in one or two of them that when they lay on their broadest surface (it can scarcely be called a "crystal face"), a principal section of the section of the crystal was just slightly inclined to a flattish side of it in a manner that suggested its not being a crystal of either of the orthosymmetrical systems. Be that as it may, it is not a diamond.

Finally, I took two of these microscopic particles and exposed them to the intense heat of a table blowpipe on a bit of platinum foil. They resisted this attempt to burn them. Then, for comparison, they were placed in contact with two little particles of diamond-dust exceeding them in size, and the experiment was repeated. The result was that the diamond particles glowed and disappeared, while the little particles from Glasgow were as obstinate and unacted on as before. I had previously treated the specimen I have alluded to as the first on which I experimented, by making a similar attempt in a hard-glass tube in a stream of oxygen, and the result was the same. Hence I conclude that the substance supposed to be artificially formed diamond is not diamond and is not carbon; and I feel as confident in the results thus obtained from a few infinitesimal particles that can hardly be measured, and could only be weighed by an assay balance of the most refined delicacy, as if the experiments had been performed on crystals of appreciable size.

Not content with merely proving what these crystalline particles are not, I made an experiment to determine something about what they are.

Heated on platinum foil several times with ammonium fluoride they became visibly more minute, and a slight reddish-white incrustation was seen on the foil. At the suggestion of Dr. Flight, assistant in this department, a master in the craft of the chemical analyst, these little particles were left for the night in hydrofluoric acid in a platinum capsule. This morning they have disappeared, having become dissolved in the acid, and on evaporation there is seen a slight white incrustation, on the capsule, of the residuary fluoride. I have, therefore, no hesitation in declaring Mr. Mactear's "diamonds," not only not to be diamonds at all, but to consist of some crystallised silicate, possibly one resembling an augite, though it would be very rash to assert anything beyond the fact that they consist of a compound of silica, possibly of more than one such compound.

The problem of the permutation of carbon, from its ordinary opaque black condition into that in which it occurs in nature as the limpid crystal of diamond, is still unsolved. That it will be solved no scientific mind can doubt, though the conditions necessary may prove to be very difficult to fulfil. It is possible that carbon, like metallic arsenic, passes directly into the condition of vapour from that of a solid, and that the condition for its sublimation in the form of crystals, or its cooling into crystal-diamond from the liquid state, is one involving a combination of high temperature and high pressure present in the depths of the earth's crust, but very difficult to establish in a laboratory experiment. I am, Sir, your obedient servant,

NEVIL STORY MASKELYNE.

Mineral Department, British Museum, Dec. 30."

PROCEEDINGS OF SOCIETIES.

NEWCASTLE CHEMICAL SOCIETY.

General Meeting, November 27, 1879.

Mr. R. C. CLAPHAM, President, in the Chair.

THE minutes of last meeting were read and confirmed.

The following nomination was made:—Mr. J. Petrie, chemical manufacturer, Seaham Harbour.

"*On Steel from Cleveland Iron*," by R. C. CLAPHAM. In the paper which I read to the Society on "Steel from Cleveland Pig-iron," at our last meeting, I alluded especially to the patent of Messrs. Thomas and Gilchrist, upon which experiments had been made during the past year in a large way at Middlesborough, and which appeared likely to lead to a successful issue; but, in doing so, I had no intention of overlooking the important discoveries of earlier investigators in the same direction, amongst whom I must name Mr. George J. Snelus, who, I believe, was the first to produce a piece of steel free from phosphorus, made by the Bessemer process from Cleveland iron in a basic lined vessel. Mr. Snelus began his investigations as far back as 1872, and, so far as I know, no one had up to that date used a Bessemer vessel lined with lime in any form, nor had anyone removed phosphorus by any process from iron during the Bessemer process. Mr. Snelus took out a patent in the same year for the use of lime, limestone, and magnesian limestone for lining converters, and at the same time he had discovered the curious property in lime, that when heated to a very high degree it was rendered incapable for a time of taking up water and slacking, and hence he suggested the practicability of making these materials into bricks, which process has, in more recent times, been so much improved upon by other inventors. I have pleasure in adding these remarks to the paper which I read at the last meeting.

Mr. BERKLEY read the following paper:—

"*Notes on Magnesian Limestone Bricks*," by P. A. BERKLEY. In bringing before the members of the Newcastle Chemical Society a few notes upon the manufacture and qualities of the magnesian limestone bricks, used by Messrs. Thomas and Gilchrist for the dephosphorising of the Cleveland pig-iron, in Bessemer steel making, I must disclaim any special knowledge or experience upon the subject, nor would I have thought of introducing the matter before this Society, except for the earnest solicitations of our President, supported by many of the members, at our last meeting. Nor am I aware that I can say much that is new. Doubtless many present have given their attention to the subject, but have gained their knowledge from those who are financially interested in the success of the discovery; therefore, a few notes by an onlooker, and the discussion that I expect will follow, may perhaps be interesting and instructive.

I was startled when I read in the papers, a short time since, that Messrs. Bolckow, Vaughan, and Co., who had discontinued bringing Spanish hæmatite ore for steel making, had again become large importers. I was afraid some hitch had occurred in the new process; but we are now informed that the firm had determined to let the Cleveland pig-iron alone, until they procured proper con-

verters, as the present ones got frequently "gobbed" with the large amount of slag that was formed.

We generally find that inventors are seldom modest enough to keep quiet until their inventions are proved a success, and while so many wonderful patents are taken out, which have to revolutionise the world, but end in nothing, the public may be excused for being a little sceptical. But I think there is no doubt that Messrs. Thomas and Gilchrist have proved that Cleveland pig-iron can be successfully used for making Bessemer steel, and that the phosphorus can be eliminated. If these gentlemen carry out their discovery to a practical and financial success, too much honour cannot be shown to them, and also to Mr. Windsor Richards, without whose aid in the experiments it is a chance that ever the scheme would have reached its present position. Of the enormous value the discovery will be to this district it is difficult to make an estimate. Mr. Richards can have little doubt of the ultimate result of the process, when, I understand, he has recommended a new plant to be procured at a cost of £10,000.

Cleveland pig-iron has never yet been used, in any considerable way, in making steel by the Bessemer process, owing to the large quantity of phosphorus it contains. Many have been the schemes proposed to get rid of this enemy.

It has generally been considered that lime would have this effect, but when the lime was added to the molten iron, it attacked the silica lining of the converter to such an extent that it was useless.

To procure a neutral lining for the converter that would resist the heat and stand the action of the lime has been the great object of experimenters. Mr. G. J. Snelus states in his paper, read before the Iron and Steel Institute this year, that "Shortly after some experiments in 1872, I found that it was possible to make bricks out of lime or limestone, provided that when the lime was used it was crushed, quickly compressed, and fired before it had time to absorb moisture, but it required intense heat to consolidate it, particularly if the lime was very pure, while a small quantity of oxide of iron or other fusible base facilitated this. If lime was used, it was necessary to be well burnt first, otherwise the material was not porous enough to allow the small quantity of carbonic acid to escape without breaking up the brick. Finding, however, that crushed limestone bent itself with considerable facility to such a purpose as lining a converter, being plastic and binding when moist, like clay, in fact, it occurred to me to use it in this form, and to fire the vessel at a very high temperature." Thus we find Mr. G. J. Snelus, in 1872, lining his steel converter with ground limestone, in fact, making a limestone brick of the shape of the inside of his converter, from which he got most successful results. He afterwards tried the same vessel lined with ganister, when the phosphorus refused to leave the metal.

Mr. Edward Riley has also manufactured lime bricks, and in order to prevent the chemical action that water had when mixed with burnt lime, he used petroleum oil, from 5 to 10 per cent. After the bricks were compressed, they were fired in the usual way, when the petroleum burnt quietly off. The following is the composition of Mr. Riley's bricks:—

Silica	8·85 per cent.
Lime	51·80 ,,
Magnesia	35·35 ,,
Alumina	2·60 ,,
Peroxide of iron	1·40 ,,
Sulphide of calcium	0·55 ,,
	100·55

I produce samples of the magnesian limestone bricks manufactured by Mr. James Tait, of Raisby Hill, made at his works at Shincliffe; also a few pieces of the limestone from which the bricks are made. Mr. Tait informs me that the limestone contains about 45 per cent of carbonate of magnesia, and 52 per cent of carbonate of lime, that it is from the Raisby Hill Quarries, and that the bricks do not contain more than 4 or 5 per cent of silica. The great aim is to get a limestone rich in magnesia. He mentioned that the Hesledon Dene stone, not far off, contained up to 70 per cent of carbonate of magnesia, but that it was very expensive to work.*

In making the bricks the limestone is ground up into powder by the same stones that are used in grinding fire clay. The crushed limestone is put into a pug mill and mixed with water; it is then moulded in the same manner as fire bricks. The bricks are then dried upon the usual flats. Nothing whatever is mixed with the ground limestone but water, which renders it quite plastic. From the flats the bricks are stacked in a covered kiln, where they are fired until they become intensely hot (to about 3000° F.)

The bricks are burnt for 108 hours. The kilns are ill adapted for the burning of these bricks, being much too high. They are capable of containing 100,000, but only some 20,000 can be safely stacked, for owing to the enormous contraction, about 40 per cent. in bulk and 45 per cent. in weight, they fall about whilst being burnt; therefore they cannot be piled high, and if they should fall upon the silica-brick lining of the kiln they cause the latter to melt, and the limestone bricks fall into powder. In these kilns the waste of heat is most excessive, therefore to have special kilns is imperative. Another serious item of cost is the enormous loss that the burners have in broken and useless bricks—about 20 per cent.

The kiln is allowed to cool down, and the bricks are taken out and dipped into tar in order to preserve them from the atmosphere.

The broken and spoilt bricks are ground up for cement, to be used in the setting of the bricks in the lining of the converters. The ground bricks are mixed with boiling tar, and this mixture used at a proper consistency whilst it is hot. The cost of the bricks is 100s. per thousand—not less. It is well known that if limestone be overburnt it is useless for building purposes, as it will not fall. The bricks by being highly burnt become most refractory; no heat seems to have any power over them. Mr. Stead, of the firm of Pattinson and Stead, of Middlesborough, states that "the greatest heat had been tried upon these bricks from an oxyhydrogen blowpipe flame, which would melt the purest silica, but it had no effect upon them; heat that would melt platinum would not affect them, and they were so dense they would not absorb water; but if they were ground very fine they would absorb water and slake."

The following analysis of the bricks now in use has been furnished me by Messrs. Pattinson and Stead, analytical chemists, of Middlesborough:—

	No. 1. Per cent.	No. 2. Per cent.
Lime	54·85	58·32
Magnesia	27·05	28·08
Peroxide of iron	3·48	3·34
Alumina	4·62	3·11
Silica	10·06	7·18
	100·06	100·03

They state that No. 1 bricks are for stock, and keep fairly well, and No. 2 are for use at once after burning. I suppose the No. 1 bricks will keep for about three months under cover.

After our last meeting, Mr. Stuart, of Hebburn, offered to test one of the bricks. About three weeks since I sent him one, and he will doubtless give you his opinion this evening of its value for chemical furnaces. He writes me yesterday that he considered the time too short (about three weeks) to fully test the refractory quality of the

* Since the above was written it has come to the writer's notice that about 45 per cent of carbonate of magnesia is the quantity.

brick. He stated to me a few days since that he had placed the brick in the hottest position he could find, and that it did not show the slightest effect from the heat, and that, after hearing the name of the maker and the price of the bricks, he would be inclined to order a quantity sufficient to line a large revolver, where there is an intensely high temperature, and where their refractory powers will be amply tested.

When at Mr. Tait's brickworks, I picked up a few pieces of limestone that were being crushed for bricks, and Mr. Kean, of Jarrow, has made the following analysis for me :—

	Per cent.
Carbonate of lime	73·366
Carbonate of magnesia	22·930
Protoxide of iron, alumina, phosphoric acid, and manganese	2·710
Insoluble residue	1·300
Moisture	0·320
	100·626
Metallic iron	1·300

Also, Mr. Kean has made he following analysis of pieces broken off one of the bricks which is on the table :—

	Per cent.
Lime	73·300
Magnesia	15·880
Peroxide of iron, alumina, phosphoric acid, and manganese	9·420
Insoluble residue	0·980
	99·580
Metallic iron	3·979

These analyses are conflicting with the statement made by Mr. Tait, that the limestone contained 52 per cent of carbonate of lime and 45 per cent of carbonate of magnesia. Probably the sample I took was not a fair one; but you will notice that putting the carbonates of lime and magnesia together you get 96·296 per cent of the stone, and that in both the limestone and the bricks the insoluble residue or silica is only about 1 per cent. It has been considered that the bricks could not be made with less than 10 per cent of silica.

The metallic iron, nearly 4 per cent, is rather against the refractory quality of the brick.

The bricks that line the converter do not seem to have anything to do with the removal of the phosphorus, but are simply neutral; it is the added basic material that is the agent. If the basic additions were not put into the converter, the silica of the iron would attack the lining to such an extent that one inch would be consumed in each blow.

Mr. Richards, in substance, makes the following remarks :—Into the steel converter, lined with these lime bricks, 7½ per cent of lime is placed. Upon this is poured 6 tons of molten iron; it is then blown with the blast, at 25 lbs. per square inch pressure, for six minutes; then there is 13 per cent of oxide of iron and lime put in among the fluid iron, one-third of oxide, and two-thirds of lime —about 20 per cent of the whole charge. The blast is then put on until the carbon lines leave the spectrum and the flame drops. It is necessary to continue the blow for two or three minutes, in order to get clear of the phosphorus.

It has been proved that the phosphorus will not leave the iron, unless the slag contains under 20 per cent of silica—hence the value of lime bricks and the addition of lime that is put into the converter. There is a loss in iron of 17 per cent, and in the working of the pure hæmatite there is a loss of 15 per cent of iron.

These limestone brick linings have stood nine blows, whilst the ganister linings have stood ten or eleven blows with hæmatite pig. There has been an idea generally prevailing that phosphorus could not be eliminated from iron at the high temperature of the converter (about 6000° F.). This has been proved to be quite erroneous by the recent experiments of Mr. Snelus and Mr. Thomas.

The President—We are all indebted to Mr. Berkley for his very useful and thoroughly practical paper. I shall be glad to hear the remarks which any of the members have to make on the subject.

Mr. Stuart—I have tested one of the bricks in various ways. I chipped a piece off, and this piece was exposed to a damp atmosphere for three weeks, without being at all acted on; it also refused to slake when immersed in water. The rest of the brick was put into a lime-kiln—the hottest we have. At the end of three weeks a portion of it broke off, but the brick was otherwise quite unacted on. Nor was it fused even by the oxyhydrogen flame.

The President—You intend to try it in a revolver?

Mr. Stuart—Yes, certainly.

Mr. Swan—Are these really magnesia bricks, or was the term a printer's error?

Mr. Berkley—It was a mistake; it should have been "magnesian limestone bricks."

Mr. Swan—I was very glad to hear Mr. Snelus's name was mentioned, for it would have been a pity to allow Mr. Clapham's contribution to go forth without Mr. Snelus's name appearing as the originator of the method which has been developed by Messrs. Thomas and Gilchrist. It was as far back as 1872 that Mr. Snelus observed that the phosphorus could be eliminated in the converter by the use of a lime lining.

Mr. Tatters—At the last meeting my friend Mr. Lyte's name was mentioned. I asked him to come down to-night to give us some information on the subject, and I have now much pleasure in introducing him to the meeting.

Mr. Lyte—I much regret I had not the advantage of being present during the reading of Mr. Clapham's interesting paper, as the subject is one which has rather engaged my attention. With regard to the durability of these bricks, I would venture to suggest a possible cause of destruction which may exist, where, as seems generally to be the case, dolomite has been used in their manufacture. We are all aware that in the scale of elective affinities CaO stands superior to MgO. We have but little experience as to whether or no the order of these elective affinities is maintained at such high temperatures as those requisite for the fusion of silicates, or at the temperature of a Bessemer converter; but, granting for a moment that such *may* be the case, it might be possibly feasible to profit by that circumstance to attain a more efficient protection for the lining, without departure from the great principles of a basic lining and a basic slag. If, instead of using dolomite in the manufacture of these bricks, they were made from Greek-stone, which is nearly pure magnesium carbonate, and if, together with the charge, enough of the mixture of lime and "Blue Billy" were added, to insure the presence of a liberal excess of lime, the corrosion of the lining might probably be—to say the least—considerably diminished. With bricks made from dolomite, containing, as it does, 75 per cent or even more of calcium carbonate, the lime portion of the bricks would be attacked simultaneously with the rest of the lime present, and as it dissolved out the remaining magnesia would be left spongy, and liable to break down and be destroyed. I may here mention that, at works near Paris, with which I was somewhat connected, where barium hydroxide was manufactured on a large scale for sugar-refiners, under the patent of M. Tessié du Motay, one of the steps of the process was the production of barium sulphide. Now, for a long time, no fettling could be found capable of resisting the fluxing action of barium compounds at the high temperatures required. M. Tessié du Motay, with that fecundity of inventive genius for which he has always been so justly celebrated, soon,

however, overcame the difficulty. He determined to line his furnaces with a basic material, and for that purpose selected magnesia. This occurred just after the Franco-Prussian war. Greek-stone was calcined at a very high temperature, becoming thereby dense but cracked in all directions. The calcined magnesia thus produced was ground, and the powder then wetted and moulded into bricks, with just enough wet precipitated magnesium hydroxide to give it coherence, and these bricks were once more strongly burnt. A furnace lined with the very best fire-brick (or bauxite) would not have lasted for as many days as furnaces so lined lasted months, on the one necessary condition, that not one bit of ordinary brick, fire-brick, furnace slag, or any acid, silicious, or aluminous material, should be permitted to come in contact with the basic lining. I have experimented rather extensively on the manufacture of these magnesia bricks, and have found that some further solidity and durability is obtainable by making them up, not with water, but with a solution of magnesium chloride, or of some other suitable magnesium salt. Chlorine, principally as HCl, is volatilised, and a firmer and harder brick is thus obtained, some magnesia being thus finally formed in the body of each brick, and binding the material more effectually together. These facts are suggestive as to the probable advantages derivable from the employment of magnesia bricks as a lining for balling furnaces, and for some similar purposes where alkalies, metallic oxides, or basic silicates or aluminates, have to be dealt with at high temperatures. It would be impossible to attempt to manufacture bricks in this manner if dolomite were employed. This material, if calcined ever so completely, could never be pulverised and then made up with water, for the lime would under these circumstances infallibly slake and break down. Magnesia, while it stands in the order of its elective affinities inferior to lime as respects acids, stands likewise, as is well known, inferior to lime in its affinity for water, and the particular advantage it possesses, making it specially adapted for the manufacture of well-formed bricks (hard, solid, and with sharp clean edges), is that once calcined it refuses to take up water, acting merely like so much sand, uncontractile and unalterable by heat or moisture, while it can be cemented together with ease, as already stated.

The President—I am sure we are all very glad to hear the remarks of Mr. Lyte, who has given so much attention to the subject of magnesia bricks. I can personally testify to the purity of Greek-stone, for we used it here some years ago for the manufacture of Epsom salts, and it was almost pure carbonate of magnesia.

Mr. Stuart—These bricks would be much more suitable than acid bricks for the lining of revolvers. The eye of the revolver next the heating furnace melts away very rapidly, from the action of the alkali on the silica at the high temperature of the furnace; in such a situation these basic bricks would probably last for an indefinite time. I think it will be well worth the while of alkali makers to go into the question. I intend to try the experiment of lining a revolver with these bricks, and I shall be glad to communicate the results to the Society.

Mr. Proctor—Can you give us an idea of the value of the pure magnesia bricks?

Mr. Lyte—I cannot at present. They cost us a good deal, for the Greek-stone then was about a thousand francs per ton. At present, however, it can be got much cheaper. I happen to be connected with the only remaining deposit—that in the Isle of Eubœa, and I have brought some over to try it. I shall be very happy to present a couple of tons of it to anyone who will try it in revolvers.

Mr. Proctor—I suppose there is no probability of them being made for 100s. per ton at present?

Mr. Lyte—No; I should say not, certainly.

The President—It is not so much the original cost of a brick as its durability which determines its cheapness.

Mr. Lyte—These bricks on the table are very dirty and deformed, and cracked in many places. Our bricks were of a pure white colour, and had an almost perfect form.

Mr. Swan—Were they as dense and hard as these?

Mr. Lyte—About the same, I should say; and they did not exhibit traces of fusion, which these do to some extent.

Mr. Stuart—If Mr. Tait could be induced to accept Mr. Lyte's offer, and make the magnesite into bricks, I should be very happy to try them. About how much precipitated magnesia was used in the moulding?

Mr. Lyte—About 5 or 6 per cent.; just enough to give them coherence. It was got by precipitating crude magnesia sulphate from Stassfürth by caustic soda.

Mr. Proctor—Would not some of these basic materials do for lime-light cylinders?

Mr. Lyte—It was with that object that M. du Motay first experimented with magnesia. He afterwards substituted other substances, notably zirconia; but he used magnesia a good deal, principally because it had so little tendency to fly off. He made his cylinders very much in the same way as the bricks. The hydrate was found to be essential to bind the magnesia together.

Mr. Swan—I made an attempt to substitute magnesia for lime, but was not very successful. I had the cyclinders turned out of the native magnesite, and then burnt; but they crumbled to pieces in the most beautifully symmetrical way soon after being taken out of the fire.

Mr. Berkley—If the magnesian limestone bricks are well burnt, they hold together very well. Their appearance has nothing to do with the result we have to get out of them. The dirt is probably due to the fact of the kilns not being suited for them, so that they have to remain very long in the kiln exposed to the dust and smoke. And their form too is not very material, for, as I have said, the waste broken bricks are made into a cement in which the bricks are bedded, and which is worked in among them until the interior of the converter is one smooth lining. With proper kilns, however, there should be no difficulty in making the bricks with a very much better appearance, and I do not see why they should not be made as cheaply as fire bricks.

Mr. Lyte—I do not allude to the colour of the bricks so much as to their shape. They seem to have become very distorted and cracked, which our bricks did not do. Our material had nndergone the whole of its contractio before being moulded; this of course could not be the case with the bricks containing lime.

Mr. Beer—How have the furnaces lined with these bricks lasted?

Mr. Berkley—About nine blows, against ten or eleven with silica bricks and hematite pig.

Mr. Stuart—I think with Mr. Berkley that Mr. Lyte exaggerates the importance of the shape of the bricks. If they will only stand the fire, there will be no difficulty in using them.

The President—Mr. Watson has put a piece of brick into my hands, which is much better in appearance than those on the table, and probably approaches nearer to Mr. Lyte's bricks.

Mr. Watson—I got it at Messrs. Bolckow and Vaughan's. It has been exposed for a month to the atmosphere, and shows no change.

The President—The question is being rapidly raised into prominence, and will become still more important in the future, if Messrs. Thomas and Gilchrist succeed. We must receive the paper and remarks of Mr. Berkley with peculiar interest, for we know he has paid much attention to the manufacture of iron in all its stages; he has been working at it with unwearied industry ever since I firs knew him, more than twenty years ago. At the same time I must express our indebtedness to Mr. Lyte for the information he has given us on pure magnesia bricks. It is quite possible that Greek-stone might be imported here, and bricks manufactured from it at a price which would make them very valuable.

"*On the Noxious Action of Acid Vapours on Vegetation.*" By Dr. G. Lunge.

NOTICES OF BOOKS.

The Sizing of Cotton Goods; and the Causes and Prevention of Mildew. By W. Thomson, F.R.S.E., F.I.C., F.C.S. Second Edition. Manchester: John Heywood.

Our readers will doubtless remember the first appearance of this work, and if so, will feel little surprise that a second edition should so speedily be called for. Sizing is undoubtedly one of the questions of the day, and all who take upon themselves to discuss it in public should at least make themselves acquainted with its true nature, with its dangers and advantages, and with the arguments used for its practice and continuance. Too many journalists, statesmen, political economists, and lawyers have omitted this preliminary step, and have consequently come to somewhat rash conclusions, which have been eagerly circulated in foreign countries, with comments highly unfavourable to British commercial morality. It is remarkable that an eminent continental journal, whilst from time to time indulging in strictures upon heavily-sized cotton goods, has till very lately defended the practice of weighting silks! It is neither our place nor our wish to defend either of these practices, but in fairness we may give an abstract of the arguments advanced by our author to show the necessity of the practice. It can scarcely be called a fraud if the merchant and the consumer buy it, as is asserted, knowingly and by preference, paying a price correspondingly less than what would be charged for "pure" cottons. Lancashire manufacturers must produce what the natives of India, China, and other countries demand, and not what is thought would be best for them, and if they object, the people of some other nation would doubtless step in. "Heavily-sized cloth is undoubtedly better adapted for many purposes for which the natives use it than a pure cotton fabric, besides being less costly." Manufacturers would, as a rule, rather make pure cloth, but the demand for that commodity is so limited that they are obliged to adapt themselves to the requirements of the market.

All the arguments are, of course, liable to be called in question. There are outsiders who would like proof that heavily-sized calicoes are preferred by any large class of consumers to a pure fabric, and that the former are really lower in price in a fair proportion to the amount of foreign matter present. It would be well if on these points some satisfactory evidence could be laid before the public.

We come to the subject of mildew. Every one has heard occasionally of bales of cotton, on arriving in India and China, being found mildewed, and sold in consequence at a loss, and the question arises how far is this evil due to heavy-sizing? Here, we think the representatives of the cotton trade are evidently in the right. A "pure" calico, where the warp is merely dressed with the small proportion of size necessary for weaving, will, if exposed to moisture, a sufficient temperature, and to the spores of certain low forms of vegetable life, become covered with minute fungoid growths. On the other hand, a heavy-sized cloth, if the sizing contains a due proportion of some antiseptic matter, such as the chloride of zinc, will remain free from mildew. Some of the substances most largely used in sizing, such as China clay, have no tendency to foster mildew. Others, such as the chloride of magnesium, have this undesirable property in virtue of the deliquescent nature, which keeps the tissues damp. The more chloride of magnesium is used, the greater is the need for chloride of zinc. Hence it is unfortunate and reprehensible that the chloride of magnesium should be sold under the name of "antiseptic." "Septic" would be much more appropriate.

Whatever conclusion is come to on the abstract morality of heavy-sizing, it will, we think, be granted that if the operation is to be performed at all it should be done on scientific principles, by which means a variety of accidents, losses, and causes of dispute between manufacturers and their customers will be prevented.

The author, in this edition, has treated of the propagation and growth of mildew to some extent, and has entered upon the difficult and delicate question of determining whether a stain upon cloth is due to fungoid growths or to other causes.

Sizing and Mildew in Cotton Goods. By G. E. Davis, F.G.S., F.I.C., C. Dreyfus, Ph.D., F.I.C., and P. Holland, F.C.S. Manchester: Palmer and Howe. London: Simpkin, Marshall, and Co.

This work has reached us almost simultaneously with the kindred treatise of Mr. Thomson. On a great majority of the points concerned both authorities are substantially agreed. On the morality of sizing, on the nature and properties of the various articles used in the process, and on the mechanical appliances required there is little difference. Messrs. Davis, Dreyfus, and Holland have, however, entered more deeply than has Mr. Thomson into the nature and characteristics of microscopic fungi, to which they have devoted four chapters of their book. In this department they have secured the valuable assistance of the well-known mycologist, Mr. Worthington Smith, and of the Rev. J. E. Vize.

The appearance of the work before us may, perhaps, be traced to what is now known as the "Manchester Goods Case," in which Mr. Thomson appeared on behalf of the plaintiff and Messrs. Davis and Dreyfus for the defendants.

It appears that a certain quantity of grey shirtings were manufactured by Messrs. Langton and Riley, and sold by them to Mr. Provand for exportation to China. On arrival there the goods were found discoloured with brick-red stains, which depreciated their value. The plaintiff, therefore, brought this action against Messrs. Langton and Riley contending that these stains were mildew, produced by an improper mixture of the size, or as the lawyers preferred to say, "to the admixture of deleterious chemicals." The defendants, on the other hand, maintained that the mischief arose not from fungi, or from any fault or defect in the sizing, but from colouring matters evolved from the tar-cloths used in packing. The former view was upheld by Mr. Thomson and Mr. C. E. Groves, and the latter by Prof. Roscoe, Dr. Carnelly, Dr. Dreyfus, and Mr. Davis. Ultimately a verdict was given for the plaintiff, but as the defendants applied for a new trial, which has not yet taken place, we cannot express any opinion as to the cause of the discolouration.

The scientific evidence contains, however, some noteworthy points. Mr. Thomson gave the very important statement that he had "actually transplanted the fungus, having scraped some of the colouring matter and placed it on flour paste, when in a few days a red fungus made its appearance precisely similar to the one in the cloth, and gradually covered the whole paste from the top to the bottom." He admitted, however, that the supposed fungus had "no form from which to make a drawing." He also added that "coal-tar contains colouring matter but not tarpaulin tar." Mr. Groves also admitted that he could detect no spores under the microscope. Dr. Paul is reported to have deposed that wood-tar, which is used in the manufacture of tar-cloth, "contains little or no colouring matter."

On the other hand, Prof. Roscoe stated that the starch-granules and the warp of the cloth both remain intact; whilst if mildew had been present they would have been eaten away. Dr. Carnelly declared that no fungus-like form could be seen on microscopic examination. Mr. Davis deposed that though red mildews existed they had definite forms; that wood-tar contains certain well-known colouring matters, and that he had failed to propagate the discolouration upon damp cloth in a hot place. Lastly, Dr. Dreyfus produced printed calico dyed with wood-tar colours, and swore to having seen red stains on bleached goods before where tarpaulin only had been used.

The discrepancies and contradictions in the scientific evidence are not a pleasant subject to consider. In their

final chapter the authors, without throwing out imputations against anyone, make some very pertinent remarks on scientific witnesses and scientific evidence. They point out the utter incapacity for any ordinary jury, whether common or special, to decide such questions as the following:

Were the red stains mildew or not?

Have fungi a definite form?

Can colours be produced from wood-tar?

They submit that in this case the jury should have been composed of three merchants, three manufacturers, three botanists, and three chemists. After quoting from Dr. Angus Smith's 12th and 13th Annual Reports a most important passage on the position of scientific witnesses, they give a suggestion of their own which to us seems worthy of very serious attention. They propose that the plaintiffs' and defendants' experts might meet in committee, having first made their analyses and other investigations apart, and compare results, "each pointing out to the other any weak points in the mode of procedure or line of argument of his *confrère*.

We must not forget to mention that one of the foreign journals which have commented most severely in reference to this case upon the conduct of English cotton manufacturers, still does not scruple to insert advertisements of the chloride of magnesium as a sizing ingredient!

It is no disparagement to Mr. Thomson's treatise to say that there is decidedly room for the work of Mr. Davis and his colleagues. Both the chemist and the manufacturer, if desirous of thoroughly understanding the sizing question in all its bearings, should possess both these books.

Annals of Chemical Medicine, including the Application of Chemistry to Pathology, Physiology, Therapeutics, &c. Vol. I. Edited by J. L. W. Thudichum, M.D. London: Longmans, 1879.

The position which Dr. Thudichum has won for himself as one of our leading physiological chemists renders him particularly fitted for conducting a periodical like the present, which purposes from time to time to lay before the medical and chemical professions accounts more or less condensed of the latest researches carried out in physiological, pathological, chemical, and pharmaceutical laboratories in Great Britain and elsewhere. In the present volume we have some twenty-three papers, most of which were read by Dr. Thudichum himself before the Pathological Institute, many of them being more or less summarised. A few of the subjects treated of will show the scope of this new candidate for public favour—the colouring matter of shells, the organic acids of the brain, a very interesting biographical sketch of R. J. Mayer, bile pigments, the urine alkaloids, antiseptic surgery, &c. Dr. Thudichum's style at times approaches the pedantic, and we feel obliged to quarrel with him for trying to render the confusion which already exists in our system of chemical nomenclature and spelling worse confounded by introducing such words as baryum, oxyde, hydrochlor (HCl), hydrothion (H_2S), molecle for molecule (which looks like a misprint), and last but not least, to fell for to precipitate. We suppose he would describe the process of forming the *arbor saturni* as *felling* a lead tree. There are two excellent name and subject indexes, and the book is well and clearly printed. Having so persistently regretted the ignorance of chemistry which is prevalent amongst our medical men, we are glad to welcome a periodical which will do much to dispel this lamentable want of knowledge.

South London School of Pharmacy.—At the Annual Dinner, on the 19th December, at the Horns Assembly Rooms, Dr. Julius Pollock presented the Medals and Certificates to the following successful Candidates:—Senior Chemistry Medal, Mr. Eaton; Certificate, Mr. Harburn. Junior Chemistry, Medal, Mr. Banks; Certificate, Mr. Littlefield. Materia Medica, Medal, Mr. Littlefield; Certificate, Mr. Slices. Botany, Medal, Mr. Parkes; Certificates, Messrs. Banks and Grover. Pharmacy, Medal, Mr. Webb; Certificates, Messrs. Fidles and Beech.

CORRESPONDENCE.

WATER OF THE CARISBROOKE CASTLE WELL.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xl., p. 310, appears a paper read before the Manchester Literary and Philosophical Society, on the "Water of the Carisbrooke Castle Well."

I published a full analysis of this water in January, 1878, (*Sanitary Record*, vol. viii., p. 18), which was afterwards reprinted in *Seaside Water*. This analysis gives the missing figures which Mr. Grimshaw asks for, namely—

	Grain per Gallon.
Nitrogen as ammonia	0·0030
,, albuminoid ammonia ..	0·0114
,, nitrates	0 7620
,, nitrites	traces

My sample was of course examined while fresh, and had therefore no smell of sulphuretted hydrogen; but I found only 0·18 grain per gallon of volatile matter, as against 19·60 found by Mr. Grimshaw. Assuming the latter figure to be correct as to the sample referred to, that alone should be sufficient, not only to condemn the water, but to render the presence of sulphuretted hydrogen after the sample had been kept for five months extremely probable. Such an increase in volatile matter is, however, curious when the character of the well is considered.—I am, &c.,

G. W. Wigner.

Laboratory, 79, Great Tower Street, E.C.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 23, December 8, 1879.

Remarks on the Saccharoses.—M. Berthelot.—The substance recently discovered by M. Peligot offers a striking resemblance to trichalose, which, however, is not quite its equal in stability. The author considers that his theory of the saccharoses distinctly foretold the synthesis of this class of compounds.

Relation between the Heat of Solution and the Heat of Dilution in Complex Solvents.—M. Berthelot. —Suppose two complex solvents at one and the same temperature, and dissolve in each of them a third body, which is in a fixed proportion with the substance already mixed with the water. The difference between the two heats of solution is equal to the difference between the two heats of dilution, observable on adding to the concentrated liquid before and after having dissolved in it the third body, the water necessary to bring it to the state of a diluted liquid: $D'-D=\Delta-\Delta'$. Thus, if we dissolve a given weight of cuprous chloride in an aqueous solution of hydrochloric acid which disengages D, and then dilute the liquid with a known weight of water which disengages Δ; or if we dilute with the same weight of water the same acid solution, which disengages Δ', and then dissolve in the dilute liquid the given weight of cuprous chloride, which liberates D', then the initial and final state being the same—$D+\Delta=\Delta'+D'$.

Coloured Rings produced on the Surface of Mercury.—M. Adr. Guebhard.—If the grey pellicle formed on the surface of impure mercury is carefully swept away, a surface is obtained the brightness of which is, for the moment, as great, and the mobility less, than those of

pure mercury. The moisture of the breath produces upon such a surface magnificent systems of coloured bands. More striking results are obtained on substituting for the breath the vapours of certain volatile substances, such as the common essence of petroleum. With collodion diluted with ether the author obtains pellicles which may be detached from the mercury after having regulated the colour and the thickness at pleasure.

Protochloride of Copper.—M. Berthelot.—The heat of solution of this salt in dilute hydrochloric acid varies according to the degree of dilution from −0·4 to −4·75. The formation of anhydrous Cu_2Cl liberates +35·6.

Reply to the Questions on the Origin of Chlorophyll, contained in the last Notice, by M. Chevreul (*Comptes Rendus*, p. 917).—A. Trécul.—This paper is rather of a botanical than of a chemical nature.

Reply to M. Trécul and M. Chevreul on Crystalline Chlorophyll.—M. Arm. Gautier.—The author considers that the function of chlorophyll is not, as commonly supposed, to decompose carbonic acid under the influence of light. It appears to be merely a secondary agent destined to absorb and extinguish the red and yellow light-rays. After being thus modified in the leaf, the luminous *vis viva*, transformed into heat and chemical action, is utilised by the protoplasm of the chlorophyll globules to produce the reductions peculiar to the green parts of plants.

An Alcoholic Fermentation.—M. D. Cochin.—A reply to M. Berthelot's remarks in the sitting of the Academy on November 17th.

Chemiker Zeitung.
No. 49, 1879.

Determination of Potassium as Platino-potassic Chloride.—Dr. H. Precht.—The author treats, in the first place, of the preparation of platinum chloride from residues. The concentrated alcoholic solutions are reduced, at a boiling temperature, by a mixture of soda solution and glycerin. Platino-potassic chloride is also completely reduced if gradually added to the boiling mixture, and if sufficient sodium carbonate is present. The precipitate of platinum-black is washed by decantation in a porcelain capsule till all sulphuric acid and potassium are eliminated, dried, ignited, and digested at a gentle heat in hydrochloric acid, to which sufficient nitric acid is gradually added. The solution is evaporated down at a gentle heat; the platinous chloride is converted into platinic chloride by the addition of fuming hydrochloric acid and a little nitric acid; the excess of the latter is expelled by the repeated addition of water and hydrochloric acid, and evaporation. The presence of platinous chloride is detrimental for the determination of potassium, rendering the results too high, whilst nitric acid occasions an error in the contrary direction. Traces of iridium have little effect on the accuracy of the analysis. Precht gives the solubility of platino-potassic chloride in alcohol as 1 part in 42,600 absolute, 1 part in 37,300 at 96 per cent, and 1 in 26,400 at 80 per cent. Platino-sodic chloride is soluble in boiling water in almost every proportion. Platino-baric chloride has the important property of being more or less completely decomposed into platinum chloride and barium chloride. Precht conducts the determination of potassium as follows:—The sulphuric acid is removed by barium chloride in a solution containing 0·5 of hydrochloric acid to 1 of the salt. The clear liquid should contain neither barium chloride nor sulphuric acid. Traces of the latter may be removed in the measuring vessel by finely pulverised barium chloride. Small quantities of sulphuric acid are admissible if the solution with platinum chloride is not evaporated quite to dryness. In acid solutions the objection to the removal of sulphuric acid by means of barium chloride—*i.e.*, that alkalies are carried down along with the barium sulphate—has little foundation. In neutral solutions so much potassium sulphate is thrown down that an error of 1 per cent may be occasioned. In evaporating down with platinum chloride care should be taken that large crystals of platino-sodic chloride are not formed, which would interfere with washing. The latter process is best performed with hot alcohol, there being no danger of the reduction of $PtCl_4$. A mixture of alcohol and ether is not to be recommended, nor an addition of glycerin. For the determination of small quantities of potassium chloride along with an excess of sodium chloride, Precht evaporates 10 to 100 grms. along with a solution of platino-sodic chloride of known strength. The potassic salts are thus thrown down, the excess of the sodium compound is washed away with absolute alcohol, the platinum reduced on the filter, and weighed.—*Zeitsch. Anal. Chemie*, xviii., 509.

Verhandlungen des Vereins zur Beforderung des Gewerbfleisses. November, 1879.

At the meeting of the Society Dr. H. Grothe read a paper on the "International Exhibition of Arnheim." It is remarked that the glass manufacture has recently made considerable progress in Holland.

M. Bernstein read a paper on the "Methods of Testing the Inflammability of Crude Petroleum." He remarked that at present Germany is the market for such oils as cannot be legally sold in other countries. He described and criticised the various apparatus in use for the determination of the flashing-point.

Composition of the "Weldon Mud," and some Similar Compositions.—Jul. Post.—The reproduction of this interesting paper is specially prohibited.

Moniteur Scientifique, Quesneville.
December, 1879.

Sittings of the Chemical Committee of the Industrial Society of Mulhouse.—On April 9th, the Secretary read a memoir by M. G. Engel, from which it appears that the silicious tubes of infusoria have a strong analogy with cellulose as regards their behaviour with mordants and colouring matters.

On June 11th, M. Camille Koechlin complained of the contamination of cœrulein with gallein. Cœrulein shades topped with gallein gain in body but lose in brightness and after steaming, take a greyish tone.

On September 10th, M. Colin gave a preliminary account of a new soluble black colouring matter, derived from aniline, and capable of being fixed on calico by a passage through bichromate. M. Endler proposed to modify the manganese-bronze process by a subsequent treatment with the chromate of ammonia instead of caustic soda. He ascribes the "greening" of aniline-blacks not merely to the action of acid fumes, but to the decomposition of amylaceous matter present.

On October 8th, M. Prud'homme explained the action of the bisulphite of soda in cœrulein shades. It appears not to behave merely as a reducer or a solvent, but to form with the cœrulein a definite compound.

MEETINGS FOR THE WEEK.

MONDAY, 5th.—London Institution, 5.
—— Medical, 8.30
TUESDAY, 6th.—Royal Institution, 3. Juvenile Lecture "Water and Air," Prof. Tyndall.
—— Zoological 8.30.
WEDNESDAY, 7th.—Geological, 8.
THURSDAY, 8th.—Royal, 8.30.
—— Royal Society Club, 6.30
—— Royal Institution, 3. Juvenile Lecture "Water and Air," Prof Tyndall.
—— London Institution, 7.
FRIDAY, 9th.—Astronomical, 8.
—— Quekett, 8.

BURNDEN CHEMICAL WORKS, AND OTHER PREMISES, AT BOLTON, LANCASHIRE.

VALUABLE LEASEHOLD LAND, BUILDINGS, WORKING PLANT, MACHINERY AND APPARATUS FOR MANUFACTURING SODA ASH, SULPHURIC ACID, MURIATIC ACID, BLEACHING LIQUOR, SULPHATE OF COPPER AND BRONZE ASH; ALSO VALUABLE DYE WORKS, AND FOURTEEN MESSUAGES OR DWELLING-HOUSES.

LOMAX, SONS, & MILLS, will SELL by PUBLIC ACUTION (by order of the Mortgagees), at the THATCHED HOUSE HOTEL, New Market Place, in the City of Manchester, on Tuesday, the 20th day of January, 1880, at Two for Three o'clock in the afternoon (unless previously disposed of by private contract), subject to such conditions as will be then and there produced,—

ALL THOSE VERY VALUABLE AND EXTENSIVE CHEMICAL WORKS, situate in Burnden Street, Manchester Road, Bolton, in close proximity to the Lancashire and Yorkshire Railway, known as the

BURNDEN CHEMICAL WORKS,

consisting of Ore-breaking Shed, Pyrites and Sulphur Burning Houses, Sulphate of Copper Sheds, Salt Cake Shed and Store, Bronze Ash House, Chemical Shed, Rectifying and Cooling Houses, Loading Shed, Ash Sheds, Cooper's Shop, Ash Packing Place, Joiners' and Mechanics' Shops, Engine and Boiler-houses, Wheelwright's Shop, Smithy, Nitre Store, Stabling for 17 Horses, Provender Place, Hay and Straw Stores, Private and General Offices, Laboratory, Machine-house, Chimneys, and other erections; together with the Steam-boilers, Steam-engines, Millwright's Work, Steam, Gas, and Water Piping belonging thereto: and also the whole of the Working Plant, Machinery, and Apparatus set up, affixed, and belonging to the several departments of the said works and premises, and capable of manufacturing monthly upwards of 1000 tons of Soda Ash, Sulphuric Acid, Muriatic Acid, Bleaching Liquor, Sulphate of Copper, and Bronze Ash. The Working Plant consists of Black Ash Furnace, four Cast Iron Lixiviating Vats, Steam Jets, Liquor Wells, Liquor Settler, Evaporating Pan, Salting Down Pan, Soda Ash Finishing Oven, pair of Ash Crushers, and Rotating Sieve; 14 Pyrites Burners, two Nitre Ovens, Lead Concentrating Tower, three Vitriol Chambers and three Nitre Recovery Towers, Air Engine by Daglish and Co.; four Acid Eggs, four Liquor Cisterns, Boiling-down Pan, eleven Sulphur Burners, Vitriol Wash Tower, five Vitriol Chambers, and two cisterns, three Boiling-down Pans, Sixty Rectifying Furnaces, Salt-cake Pot and Roaster, eight Stone Acid Cisterns, and two Stone Condensing Towers, seven Stone Chlorine Stills, five Stone Bleaching Vessels, with Gearing and Agitators, Liquor Well, Stone Acid Cisterns, Lead and Iron Chemical Tanks, Feed Pump, Ore Grinding Mill, Riddling Machine, Copper Calcining Furnace, Wagon Hoist, Tramways and Turntable, Wash Tower, six Extracting Vats, Liquor Settler, two Precipitating Tanks, Copper Vat, Precipitate Roasting Furnace, three Evaporating Pans, thirteen Lead Crystallising Pans, Liquor Well, Steam Pump, Drying and Sampling Benches, two Boiling-down Pots and Furnaces, Drying Furnace, Boiling-down Pan and Furnace, Drainer and Well, Mortar Mill, Chaff-cutting Machine, Ten-ton Wagon Weighing Machine, and Office Fixtures; together also with the THREE PLOTS of LAND, forming the site thereof, and occupied therewith, and containing altogether 24,318 square yards, or thereabouts.

The Premises are Leasehold, and are held for the residue of three several terms of 990 years, 999 years, and 990 years, subject to three several ground rents amounting in the aggregate to £120.

The Buildings, which are brick-built and slated (the sheds being erected on brick pillars), are excellently adapted for the purposes of the business, a large sum of money having been expended in their construction (a considerable portion of such sum within the last few years), and are most eligibly situated, the Lancashire and Yorkshire Railway being immediately contiguous to the Works. Gas and Water Mains are laid throughout, and there is a never-failing supply of water for all purposes. Immediate possession can be had.

Also those valuable PREMISES, situate in Burnden-fold aforesaid (adjoining the last-described premises), formerly used as a DYE WORKS, with the STEAM BOILER, STEAM ENGINE, SHAFTING, GEARING, PIPING, and FIXTURES thereto belonging, which, with the ELEVEN COTTAGES adjoining, being Nos. 3, 5, and 7, Haslam-street, 11, 13, 15, and 17, and 9, 25, 27, and 29, Burnden-fold aforesaid, and the site whereof contains 1302 square yards, are held for residue of term 999 years, at yearly rent of £7 14s. 1½d., and are subject to a lease for five years, at the yearly rent of £70, and will be sold subject to such lease.

Also all those TWO MESSUAGES, or DWELLING-HOUSES, and CELLAR, with the YARD, OUTBUILDINGS, and APPURTENANCES thereto belonging, situate and being Nos. 209, 211, and 213, Manchester-road, and 6 and 8 at the back, and known as Back Burnden.

Site, 248¼ square yards. Term, 999 years. Apportioned yearly rent, £2 2s. 10d.

The whole of the foregoing properties will, in the first instance, be offered for sale in One Lot, and if not so disposed of will then be offered in Two Lots, viz.:—

LOT 1. Land, Chemical Works, Dye Works, and Dwelling-houses.

LOT 2. The whole of the Plant and Machinery.

Full particulars of which will be given on application to Messrs. P. and J. KEVAN, Accountants, 12, Acresfield, Bolton; the AUCTIONEERS, 15, Wood-street, Bolton; Messrs. RICHARDSON and MARSHALL, Solicitors, 18, Wood-street, Bolton; or to

Messrs. HOLDEN and HOLDEN.
Solicitors,
Bolton.

The Prestolee Alkali Works, Farnworth, near Bolton, Lancashire fitted with costly plant, machinery, and apparatus for the manufacture of soda-ash, bleaching-powder and liquor, and sulphuric acid, in complete working order. With possession.

MESSRS. FULLER, HORSEY, SONS, and CO., are instructed to SELL by AUCTION, at the Palatine Hotel, Manchester, on Friday, January 16th, at 3 precisely, in one lot (unless an acceptable offer be previously made by private contract), the PRESTOLEE ALKALI WORKS, a freehold property, having a superficial area of 95,741 square yards of land, subject to chief rents amounting to £407 13s. 9d. per annum, with the buildings, plant, machinery, and apparatus erected thereon, capable of manufacturing monthly a product exceeding in the aggregate 2000 tons of soda-ash, bleaching-powder and liquor (by Weldon's patent process), and sulphuric acid, also caustic soda and muriatic acid. The amount expended in the construction of these works has been very large. A valuation was made with great care in 1874 by Messrs. Holmes and Son, the well-known valuers, of Manchester; their estimate then amounted to £99,900, and since that time a sum exceeding £10,000 has been expended. The whole of the works and plant have been well kept, and are conveniently arranged for working. The Bury, Bolton, and Manchester Canal, which forms one boundary of the property, affords facility for economical water carriage, and the Lancashire and Yorkshire Railway is within a very short distance. There is a plentiful supply of water for all manufacturing purposes, free of cost, from the river Croal, and coals are raised from pits in the immediate neighbourhood. Pyrites, salt, lime, and limestone are all brought by boats direct to the wharf on the canal. The works may be economically worked with a small capital, as arrangements may be made with the vendors for a very considerable portion of the purchase-money to remain upon mortgage. Large profits have been realised in the past, and the high reputation of the Prestolee manufactures in the market will ensure to an energetic man, even at the existing low prices, an ample return for his capital invested, and possession of works not surpassed for completeness or compactness by any in the kingdom. May be viewed till the sale. Printed particulars may be had at the works; at the Palatine and Queen's Hotels, Manchester; of Messrs. Wakeman and Bleeck, Solicitors, Warminster; of Messrs. Christopher and Son, Solicitors, 28, Argyll Street, Regent Street, W.; and of Messrs. Fuller, Horsey, Sons, and Co., 11, Billiter Square, London, who are empowered to treat for the disposal by private contract, or an offer for renting would be entertained.

UNIVERSITY COLLEGE, BRISTOL.

CHEMICAL PROFESSORSHIP.

The Council invite Applications for the Chair of Chemistry. Salary, £300, with a share of the Students' Fees. Applications, with testimonials, to be sent not later than 9th February, 1880. Further information may be obtained from the Principal on application to EDWARD STOCK, M.R.C.S., Secretary.

TO INVENTORS AND PATENTEES.

R. E. FARRANT and Co., Dextrine Manufacturers, Gorton Gum Works, Manchester, are prepared to undertake the manufacture of any Chemical or Foods Speciality, or to furnish assistance (if required) with ample and superior accommodation, with steam-power, to any inventor or patentee desiring to manufacture.

THE JOURNAL OF SCIENCE

AND ANNALS OF

ASTRONOMY, BIOLOGY, GEOLOGY, INDUSTRIAL ARTS, MANUFACTURES, AND TECHNOLOGY.

This Journal is a medium of communication between the Scientific Investigator and the Reading Public, and also between Students in the various branches of science.

Price One Shilling and Sixpence.

Now ready, No. LXXIII., *January*, 1880.

CONTENTS.

The History of Evolutionism.
Scientific Progress of the Past Year. By Wm. Spottiswoode, D.C.L., LL.D., P.R.S.
The Hon. Henry Cavendish; his Life and Character.
English and American Physique. By George M. Beard, M.D.
On Water and Air. By Prof. Tyndall, D.C.L., LL.D., F.R.S.
The Thomas and Gilchrist Process for Eliminating Phosphorus in the Manufacture of Steel. By W. Mattieu Williams, F.R.A.S.
Professor Barff's Process for Preventing the Corrosion of Iron.
Analyses of Books, &c., &c.

London: 3, Horse-Shoe Court, Ludgate Hill.

THE CHEMICAL NEWS.

Vol. XLI. No. 1050.

THE CRYSTALLISATION OF CARBON.

Since sending the telegram* announcing that carbon crystals, apparently diamond, could without difficulty be produced from any carbon compound, Mr. Mactear has sent me several specimens of his supposed artificial diamond. He has also called upon me with other specimens, and has explained the whole process by which he obtains such remarkable results. As, however, he has sent to the Royal Society a paper which will probably be read in the course of a week or two, I am not yet at liberty to give details of the process.

The general character of the specimens now in my possession may be described as irregularly shaped masses from 1 m.m. downwards in diameter, with rounded angles, and showing no definite crystalline appearance. They are whitish looking, translucent, and as a rule lustreless; many pieces are almost spherical and appear like fragments of corundum which have been water worn. Amongst these are perfectly clear fragments larger in size, some being 3 or 4 m.m. across, having a conchoidal fracture exactly like glass.

In a paper "On Molecular Physics in High Vacua," read before the Royal Society in March last, and now being published in the *Philosophical Transactions*, I referred to the remarkable power possessed by the molecular rays in a high vacuum of causing phosphorescence in bodies on which they fall, and I remarked that the only body which surpassed Becquerel's luminous sulphides both in brilliancy and variety of colour is the diamond. Most of these gems, whether cut or in the rough, when coming from the South African fields, phosphoresce of a brilliant light blue colour. Diamonds from Brazil shine with different colours, such as bright blue, pale blue, apricot, red, yellowish green, orange, and light green. A beautiful collection of diamond crystals, kindly lent me by Professor Maskelyne, phosphoresced with nearly all the colours of the rainbow, the different faces glowing with different shades of colour. On receiving the specimens from Mr. Mactear, I immediately submitted them to the molecular discharge. The following are the results I have at present obtained:—

In a high vacuum the specimens phosphoresce brightly of different colours—pale blue, orange, apricot, and yellowish green. The clear glassy fragments are also phosphorescent. The appearance of the phosphorescence is very similar to that shown by small rough diamonds from Brazil, called in the trade "Boart;" indeed, had I not known the history of the fragments in my tube, I should, from their appearance, have said that they were small fragments of Brazilian Boart.

The opaque rounded appearance of the fragments is unlike that of the natural diamond, but by heating a rough diamond before the blowpipe until it has partly burnt away, it assumes a very similar appearance to that of Mr. Mactear's crystals, and it is therefore not unlikely, from their mode of preparation, that these crystals have undergone partial combustion after their formation—a fact which would explain this difference in appearance. Other specimens having been placed by Mr. Mactear in competent hands, with a view of determining their hardness and chemical properties, I have refrained from making experiments in this direction. W. C.

* Chemical News, vol. xl., p. 306 (Dec. 26, 1879.)

ON THE REDUCTION OF AURIC CHLORIDE BY HYDROGEN IN PRESENCE OF PLATINUM.

By Dr. T. L. PHIPSON; F.C.S., &c.

This experiment, which is so illustrative of what is termed the "nascent state" of bodies, was originally made by Becquerel; it was afterwards repeated by me and explained in my paper, "La Force Catalytique, Etudes sur les Phenomènes de Contact (*Memoire couronné par la Société Hollandaise des Sciences*, Harlem, 1858). A platinum wire which plunges into the auric chloride and the gas occasions the precipitation of gold, whilst the hydrogen disappears. I translate the following lines from my paper of 1858:—

"In this experiment the hydrogen is burnt by the chloride of gold instead of by oxygen as in the first experiment: the positive electricity of the platinum unites with the negative electricity of the hydrogen, and the negative fluid of the platinum unites with the positive electricity of the salt [this was the language used in those days; but whatever the language, the galvanometer proved the electric action and direction of the current]; hence the hydrogen reduces the latter; there is formed hydrochloric acid and metallic gold. The same thing would occur by operating *without the platinum* [that is, without the electric action], but *only at a high temperature*, as we have already seen for hydrogen and oxygen alone, for heat developes polarity as does the presence of a third body."

Now, in the whole of this paper, of thirty-four pages in quarto, the term "polarity" has been shown to be equivalent to the term "nascent state." It is, therefore, evident that I was occupied with this question nine years before M. Berthelot, and nineteen years before M. Tommasi. The latter, in a paper published in a recent number of the Chemical News, referring to this same experiment, and quoting his paper of 1877, says:—"As for us we think that the reduction of the chloride of gold by means of hydrogen and platinum is due to the heat disengaged during the condensation of the hydrogen on the platinum."

It will be seen from the above quotation from my paper that this attempted explanation by Professor Tommasi is unacceptable. The hydrogen is not absorbed by the platinum wire, but by the solution of gold; it does not combine with the platinum but with the chlorine; it is a purely electric action going on in the cold, an electric action which an interposed galvanometer renders manifest, as shown in several other experiments given in the same paper.

But let me be allowed to quote one other passage from my paper of 1858:—"A porous vase is placed in a glass vessel. In the porous vase is placed hydrochloric acid, in the glass nitric acid; then, into each vessel a strip of gold. As long as the two strips of gold remain separate there is no action, but as soon as they are united the metal is attacked, and that portion which is in the hydrochloric acid is dissolved; the nitric acid is at the same time deoxidised by the *nascent hydrogen* transported through the sides of the porous vase, and an electric current flows through the strips of gold."

I trust these quotations will suffice to show that I had explained the phenomenon of the "nascent state" of bodies as early as 1858, and when any chemist shall have proved by the *thermometer* that there is a caloric action, as clearly as I have satisfied myself of an electric action by means of the *galvanometer*, I will admit his theory. I do not deny (as I have stated in a previous note) that the caloric and electric actions may be mutually convertible, but I maintain that in whatever circumstances the phenomenon of nascent hydrogen occurs, there we can detect electric action by means of the galvanometer; whereas the caloric theory is based upon purely speculative assumptions. Thus Prof. Tommasi, in endeavouring to explain the experiment which forms the subject of

this note, imagines the atoms of hydrogen playing against the platinum wire like the balls against the wall of a racket court.

In my work above quoted there are four conclusions; I may perhaps be allowed to reproduce here a literal translation of the first of them:—"1st. That the allotropic states of bodies analogous to ozone are due to a phenomenon of polarity acting in special circumstances, and having for effect to render the body on which we experiment infinitely more electro positive or electro negative than it was before; and that the state which we call in chemistry 'nascent state of bodies' is nothing more than that allotropic state."

I will only remind my readers that these words were published in 1858, whilst those of M. Berthelot are of 1863, and that Prof. Tommasi (in 1877 and subsequently), instead of assuring himself by direct experiments of the electric conditions of the substances on which he operates, contents himself with *supposing* a disengagement of caloric. If his suppositions happened by chance to be true, it is evident that caloric and electricity are one and the same thing.

ON THE NOXIOUS ACTION OF ACID VAPOURS ON VEGETATION.*

By Dr. G. LUNGE.

Under the above title, Mr. Hasenclever, the managing director of the Rhenania Chemical Works, near Aachen, has published a paper, the contents of which are not merely of great interest, but of real importance, for the British alkali-making districts. Since, hitherto, only a very short notice of this paper has been published by the Chemical News, it will hardly require an apology if I place its essential points before the Society in a more ample form.

Hasenclever commences by admitting at once the noxious action of acid gases upon vegetation, exercised wherever large quantities of such gases are given out. This takes place especially in calcining sulphurous ores and matts; large quantities are also given out by some chemical works. Complaints have also been made in some cases against ultramarine, glass, brick-works, and generally against those manufacturing establishments in which a large quantity of coals is consumed. The noxious action of acid gases on vegetation is further proved by the investigations of Stöckhardt, Freytag, and Schroeder (mentioned in my "Treatise on the Manufacture of Sulphuric Acid and Alkali," vol. i., p. 110—112 of the English edition). Hansclever himself gives excellent coloured drawings, showing the outward changes produced by acid vapours on the leaves of the carrot, Scotch fir, oak, and rose. He adds pictures of tussilago leaves damaged by flue dust, and of beech leaves damaged by frost, both of which exhibit an appearance altogether similar to that of leaves damaged by acid vapours. Since, moreover, autumnal decay, fungi, insect stings, and other influences may bring about quite similar appearances, great caution is needed before fixing upon any one of these causes as the real one; and instances are given of considerable mistakes made in this way.

When the functions of the leaves are disturbed by these spots, whatever be their cause, the trees suffer in their growth; and, if this goes on for several years, they die altogether. The decrease of growth can be observed, without cutting down the trees, by taking a sample of it by means of Pressler's auger, which shows the single annual rings.

In many places, where the action of noxious gases is quite out of the question, plantations of trees exhibit the appearance of suffering. This may be produced by the tops of some of the trees projecting too far, which interferes with the growth of their neighbours; by leaving single trees standing after cutting down those around them; and, more especially, by the drought consequent upon the regulation of water courses, the lowering of the level of lakes, and the ordinary effects of mining; and also, in towns, by the hardening of the ground round the roots produced by the street traffic. Wherever the wood is impoverished, by taking from it the decayed leaves and branches without imparting to it some kind of manure, a deterioration of the trees must necessarily follow.

Undoubtedly there are some cases where none of the causes just mentioned is present, and where acid vapours must be blamed for the destruction of vegetation. It is certain that this takes place more easily in damp than in dry weather. But the proof that such destruction is due to acid vapours, frequently sought to be obtained by a comparative estimation of chlorides and sulphates in damaged and sound plants, is anything but easy and certain. It has not been established yet that an increased percentage of acid in the leaves is regularly accompanied by a decrease of growth; neither is it known what is the maximum percentage of chlorine and sulphuric acid that leaves may absorb without being corroded. König found in the fir woods, near the Lethmathe Zinc Works, relatively considerable quantities of sulphuric acid in apparently healthy trees, whilst Schroeder found only half as much sulphuric acid in similar trees, on the Harz, which had been destroyed by noxious vapours.

No doubt, whenever much sulphur dioxide is given off, whether by the calcining of ores or in some other way, there is a good deal of sulphuric acid found in the plants. Similarly high chlorides are found near chemical works which decompose common salt, and near potteries which glaze their ware by means of salt; but both sulphuric acid and chlorine are also found in ordinary coal smoke. It is perfectly well known that formerly, when the atmosphere must have been purer from the absence of a highly-developed industry, the use of coal was disliked, and even here and there prohibited, on account of its "pestilential" smoke. Mohr asserts that the obelisk of Luxor, erected in 1836 on the Place de la Concorde at Paris, has suffered more in thirty-six years there than during as many centuries in Egypt. Rhenish and Westphalian coal contains on the average 1½ per cent of sulphur (usually in the shape of pyrites), which must pass into the air as sulphur dioxide. The injurious effect of this is frequently felt either where coal is burnt in large quantities, or where the smoke, as in narrow valleys, is not specially diluted by air. This is proved by special instances from Stöckhardt and others. The statements of Dr. Angus Smith are also quoted, according to whom London air contains, in a million of cubic metres, 1670 grams sulphuric acid, and Manchester air 2518 grams.

Chlorine also regularly occurs in coals, and is not found in their ashes, but expelled along with the volatile constituents. The chlorine of gas water must be reduced to this origin. There is also chlorine in blast-furnace gases.

Soot seems to be quite harmless by itself, as proved by Stöckhardt's experiments; but becomes very injurious to plants when containing metallic sulphates, as is often the case in industrial districts.

Hasenclever now turns to the question, how the injurious effect of acid vapour upon vegetation, whether arising from the direct evolution of such vapour or from coal smoke, may be best prevented? Tall chimneys are quite inefficient in the case of large quantities of vapours; the dilution by air, even when sufficient in fair weather, fails to act in damp weather. Only in isolated establishments, and with moderate quantities of vapours, does dilution by tall chimneys prove satisfactory. Washing out the acids from coal smoke has not been found practicable. The legal enactments for the complete combustion of smoke enforced in some English towns have done some good, but have only diminished the *black* smoke; In Germany, at watering places, and other towns or villages which depend upon the concourse of visitors, the establishment of factories is not permitted, or is at least

* A Paper read before the Newcastle-upon-Tyne Chemical Society.

restricted. Dr. Angus Smith frequently points out that too great an accumulation of industrial establishments in any one locality should be avoided. At Hanover (and some other large German towns) the existing factories are not interfered with, but no new factories are licensed within the urban district.

All this refers to coal smoke. The sulphur dioxide escaping from glass works in enormous quantities is nowhere condensed; it is too much diluted for the condensation to be effectual. In vitriol works the escape of sulphurous and sulphuric acid has been very much lessened by the introduction of Gay-Lussac towers. But considerable difficulties still exist in the case of copper, zinc, and lead smelting works. In Germany many of these now calcine the ores in Gerstenhoefer's or in Hasenclever and Helbig's kilns, and thus utilise a portion of the sulphur as vitriol. But even then the condensation of the calcining gases is not perfect, and further progress in this direction is very desirable. Still there is a considerable difference between the desolate aspect presented by the neighbourhood of those smelting works which do not condense at all, and the field and garden culture observable close to the other kind of works, although even these interfere with fir woods, fruit-bearing trees, and some other kinds of trees.

We now come to the escape of hydrochloric acid from factories decomposing common salt by sulphuric acid. Everybody knows the former state of matters in this respect as laid bare by the Belgian Commission of 1855, and the reports of the British Alkali Inspectors since 1863. The large escapes formerly complained of can be directly traced to the fact that at that period far more hydrochloric acid was produced as an involuntary by-product than could be utilised or sold. In Germany at least this is no more so; the demand for hydrochloric acid on the part of colour, copper, glue, dye, and sugar works has increased to such an extent that some factories produce this acid as their principal article, making soda-ash only as a by-product. This is best proved by the fact that no special legislation on the condensation of hydrochloric acid was thought necessary in Prussia, although the question was mooted in its proper place, because it was considered that the self-interest of the manufacturers was quite sufficient to ensure efficient condensation. The German alkali works usually possess even a larger condensing space than that laid down as sufficient by Dr. A. Smith, and no damage worth speaking of is done to vegetation in their neighbourhood where they are isolated; but where they are situated among many other industrial establishments they are sometimes singled out, and held responsible far beyond their due, for the damage unavoidable in such circumstances.

This is illustrated by a private communication to Mr. Hasenclever from Dr. Fletcher referring to the acids escaping in the neighbourhood of St. Helen's. Dr. Fletcher calculates the weekly escape from—

Fire gases at	800 tons	SO_2
Copper works at	380 ,,	,,
Glass works at	180 ,,	,,
Alkali works at	25 ,,	HCl

Hasenclever himself gives a table referring to the twenty-eight industrial establishments situated at Stolberg, near Aachen, on an area of 1600 acres, whose 220 chimneys emit in twenty-four hours 34,500 kilogs. of SO_2 from coals, and 50,858 kilogs. of SO_2 from zinc works, glass works, &c.; but only 480 kilogs. SO_2 and 750 kilogs. of HCl = 4 per cent of the total acids from the Rhenania Alkali Works.

Hasenclever concludes by admitting that acid vapours ought to be condensed as fully as possible; also that everybody ought to be made to pay fully for any damage he may have caused; but he claims that manufacturers ought not to be harrassed *beyond* their due, and he complains that public opinion is not always just in this respect. Damaged plants and trees occur in many places remote from chemical works and other industrial establishments, as proved by several photo-lithographic illustrations appended to the original, and their occurrence near such establishments should consequently not be taken as caused by acid vapours without real proof of the case.

The President—I should like to mention one circumstance before we conclude. The Committee of this Society have deliberated for some time on the possibility of amalgamating the two Societies which exist in this district. I have myself seen for several years the importance of uniting these two forces, and there seems at present a reasonable prospect of its being fulfilled. With this object, the Committees of the two Societies are going to meet to-morrow night at the house of Mr. Scholefield, who has kindly invited us; and possibly at our next meeting we may have something to communicate to the Society on this subject.

Votes of thanks were then given to the gentlemen who had furnished the material for the evening's discussion, and the proceedings terminated.

DETERMINATION OF COBALT AND NICKEL.

By E. DONATH.

E. Fleischer describes, in the *Journal fur Practische Chemie*, 1870, vol. ii., p. 48, a very useful method for the determination of cobalt and nickel together, which consists in halving the solution, and in each half converting both metals into sesquioxides, Co_2O_3 and Ni_2O_3, by boiling with hypochlorite of soda or soda-lye and bromine, and determining volumetrically the quantity of nickel in the precipitate of the one half. The precipitate of the other half is boiled previously with ammonia, which reduces Ni_2O_3 to NiO and chiefly dissolves it, whilst the oxide of cobalt remains unchanged.

This reduction by means of liquid ammonia is not sufficiently rapid and easy, as may be ascertained by direct experiment, and in the application of the above method it remains doubtful if all the nickel sesquioxide has been reduced.

The author has, therefore, adapted a modification of Fleischer's process which depends upon the following facts: If a cobalt solution is mixed with excess of potassa or soda-lye, and brought to a boil, the cobalt hydroxide is as completely converted into sesquioxide as by treatment with bromine; nickel oxide is not effected by this process. Hence in the one half of the solution of the mixed metals both are converted into sesquioxides by boiling with alkali and bromine, whilst in the other half merely the cobalt is converted into sesquioxide by a similar treatment with alkali and iodine.

The precipitate, freshly taken from the filter, is boiled with hydrochloric acid in a suitable distillatory apparatus, and the chlorine evolved according to the equation—

$$R_2O_3 + 6HCl = 2RCl_2 + 3H_2O + 2Cl$$

is collected in solution of potassium iodine, and the iodine separated is determined volumetrically by a decinormal solution of sodium dithionite.

As 1 atom of iodine corresponds to an atom of cobalt or nickel, and the atomic weights of the two latter are equal, = 59, the difference of the required number c.c. of the dithionite solution in both determinations, multiplied by 0·0059, represents the weight of the nickel; the number in the second case, where only the cobalt is converted into sesquioxide, if multiplied by 0·0059, gives the weight of the cobalt. In this modification of Fleischer's process the cobalt admits of direct volumetric determination in a single operation. In the determination of both metals, the treatment with boiling ammonia is dispensed with

and certainty is reached that the nickel is present in the precipitate merely as NiO.

In converting the cobalt into sesquioxide by treatment with iodine in an alkaline solution, the iodine is added at common temperatures as long as the colour of the precipitate grows darker, and the liquid is then raised to a boil.

If the nickel predominates in quantity, the solutions of both metals are used in a dilute state, otherwise the conversion of the cobalt into sesquioxide may be delayed by a coating of the oxide of nickel.—*Berichte der Deutschen Chem. Gesellschaft*, xii., p. 1868.

ON THE

ESTIMATION OF THE NITROUS COMPOUNDS

IN THE VARIOUS STAGES OF THE

MANUFACTURE OF SULPHURIC ACID.*

By JAMES MACTEAR, F.C.S., F.I.C.

1. A convenient, speedy, and accurate method of estimating the nitrous compounds in the various stages in the manufacture of sulphuric acid has long been a desideratum amongst manufacturers, the loss of nitrous compounds being a serious element in the cost of production, and as the whole of the nitrous compounds evolved from the nitrate of soda employed in the process of manufacture are, with the exception of the amount which is contained in the sulphuric acid as run off for sale or use, lost in the gases passing away from the chambers, it becomes a most necessary thing to ascertain the amount thus escaping.

2. The testings may be resolved into:—

a. The estimation of the nitrous compounds escaping from the leaden chambers before entering the Gay-Lussac or absorbing column.

b. The estimation of the nitrous compounds escaping from the Gay-Lussac column to the air by the chimney.

c. The estimation of the nitrous compounds arrested or absorbed by the strong sulphuric acid in the Gay-Lussac column.

d. The estimation of the amount of nitrous compounds in the acid from the denitrating column, or from the chambers when run off for use.

3. In *a* and *b* the gases being aspirated by the apparatus described in my paper on "Controlling the Escapes of Sulphur Gases in the Manufacture of Sulphuric Acid," read before this Society on 22nd March, 1877, are absorbed in caustic soda solution, and the nitrous compounds are then estimated; for this purpose I employ two methods.

4. First, by a method which I have introduced, and which I call the method of "total acids," which, while without any pretension to extreme accuracy, yet does good service, and gives remarkably consistent results. It is conducted thus:—The absorbing arrangement which I use consists of a convenient wooden stand, supporting a series of four tubes each, of about one inch internal diameter, and about fifteen inches long; these are all connected with each other by means of india-rubber corks, glass tubes, and rubber joints. The inlet tubes, which reach close to the bottom of the tubes, are made thus—the end of the tube is fused until the opening becomes very small; the tube is then, while still hot, pressed vertically on an iron plate so as to flatten and spread it out like the head of a nail; the small hole thus left only allows of small bubbles of gas passing, which are broken up by the broad flat end of the tube, and expose a large surface for absorption.

The tubes are filled with the absorbing liquid in the following way:—

In the 1st tube is put	50 c.c.	normal soda	+	50 c.c.	water
„ 2nd „	25	„	+	75	„
„ 3rd „	25	„	+	75	„
„ 4th „	00	„	+	100	„

The last tube being tinted with litmus, so that should any sulphurous acid or nitrous acid pass the three previous tubes the colour of the litmus will be destroyed, and thus it acts as an indicator of the complete absorption of the gases in the sodic solution.

The aspiration completed, the tubes are disconnected and the contents washed into a beaker and titrated with normal HCl; it is then made up to the bulk of a litre and 250 c.c. taken, and the total sulphuric acid determined by precipitation with baric chloride in the usual way.

Let us assume a case where the gases aspirated amount to 12 cubic feet,* the absorbing tubes containing 100 c.c. normal Na_2O.

After absorption the solution required 80 c.c. normal HCl to neutralise remaining soda, then as 1 c.c. Na_2O is equal to 0·617 grain SO_3, we have:—

$100-80=20\div12=1{\cdot}666\times0{\cdot}617=1{\cdot}0279$ grains; total acids per cube foot stated as SO_3.

The neutralised solution made up to a litre and 250 c.c. gave 0·300 gramme $BaSO_4\times4\div12=0{\cdot}10$ gramme per cube foot = 0·529 grain per cube foot of SO_3.

Thus we have:—

1. Total acids per cube foot	=	1·0279 grains SO_3
2. SO_3 existing as S acids	=	0·5297 „
Excess of 1 = N compounds as SO_3		0·4982 „
		1·0586

Equal to $NaNO_2$ grains per cube foot 1·0586

It can be easily seen that this method is very simple and easily applied, and as the estimation of the sulphur compounds should always form part of the work of the laboratory of every sulphuric acid manufacturer the additional labour of obtaining the nitrous compounds escaping by this method is extremely small.

The only difficulty which presents itself is in the titration of the solution, which contains invariably a not inconsiderable quantity of CO_2, which, in the presence of nitrous compounds, renders the end of the reaction rather difficult to determine.

This method I have used daily for nearly a year, and the results are most satisfactory. Compare the following tests, being for one week, stated as grains $NaNO_3$ per cube foot.

Total acid method.	Estimated as NH_3
1·56	1·40
2·68	2·65
2·41	2·38
1·66	1·53
0·88	0·96
1·52	1·42
1·88	2·08
0·55	0·46
Average 1·64	1·61

5. The method of estimation of the nitrogen as NH_3 is the method I prefer and regularly employ (using the total acid method in addition as a check and a useful comparative result.

This method of estimation has been the subject of much discussion, and seems to have been praised and condemned alternately by those who have written on the subject.

* A Paper read before the Newcastle-upon-Tyne Chemical Society.

* No correction is made for bulk of gases absorbed, only unabsorbed gases being measured.

Döbereiner (*J. pr. Chim.*, 15, 318) was, I think, the first to point out that when zinc and iron were immersed together in a solution of potash nothing but hydrogen was evolved, but if nitre be present ammonia is evolved.

The use of this reaction was first proposed by Vernon Harcourt,* as a means of estimating nitrogen compounds.

Of late there have been a number of researches published on the subject, amongst others one by J. W. Johnson,† who has investigated the methods proposed by Bunsen and Thorpe, and who condemns that of the latter as having yielded very bad results, the deficiency being in one case as much as 45 per cent.

Thorpe himself,‡ on the contrary, obtained the following results with pure potassic nitrate alone :—

	Grm.
KNO_3 used 0·0474 grm., found (1)	0·0476
(2)	0·0473
(3)	0·0487
(4)	0·0469
Average	0·0475

Equal to 100·21 per cent.

Which are satisfactory enough. He has likewise investigated the effect of various salts on the decomposition. The results will be found fully detailed in his paper.

Dr. Lunge, in a paper communicated to this Society last session, condemns, in no measured terms, this method of estimating the nitrogen acids. In his introductory remarks he says—"It thus became the first portion of my task to thoroughly examine at least those methods of estimating the acids of nitrogen which have been proposed or used for testing 'nitrous vitriol.'"

He then, after describing the estimation of N_2O_3 by the iron process of Pelouze, with various of its modifications, proceeds to treat of the method of estimation of nitrogen acids by reduction "in an alkaline solution by means of iron or zinc;" and goes on to say: "The total nitrogen is thereby supposed to be converted into ammonia." I trust to be able to show that this supposition is well founded.

He further says: "I had, however, to use caustic soda in the place of caustic potash, as I could not procure the latter free from nitre, and it is just possible that the apparently good results obtained by this process may, in some cases, be due to the employment of impure potash. I for my own part, working with rigid accuracy, and, if anything, overdoing all the precautions prescribed for this process (for instance, allowing the mixture to stand some time and distilling very slowly, say three to four hours), never obtained any satisfactory results. The ammonia produced fell short in six experiments; from 16 to 26 per cent of that calculated from the pure potassic nitrate, &c., employed. Nor could I better the case by some experiments tried with the original plan of Schultze's, and by a modification proposed by Hager. A number of chemists have come to the same conclusion, viz.: that the process of estimating nitrates by reduction in an alkaline solution cannot be depended upon; and although a number of other chemists certainly have obtained accurate results by it this may be due partly to the fact that in some special circumstances the process does work well, whilst it does not in other cases, and partly to a compensation of the loss of ammonia by the nitre consumed in the potash employed, or by carrying over of fixed alkali. A process which gives such uncertain results in spite of scrupulously carrying out the prescriptions given for it, ought not to be resorted to so long as any other process of undoubted accuracy is available."

I regret to differ from Dr. Lunge when he says that in pursuance of the determination by thorough examination and rigid accuracy he has proved the method to be one that can not be depended upon, giving results from 16 to 26 per cent under the true amount, and I base my opinion upon :—

1st. The good results obtained by so many competent chemists, most recently, perhaps, by J. M. Eder,* whose exhaustive research on the various methods of determining nitric acid is worth careful study.

2nd. The results of my own experience of the method of using zinc and iron with caustic soda. This method has been employed almost daily in the laboratory of the St. Rollox Works for many months, some hundreds of tests having been made by it, and the results have proved perfectly consistent and satisfactory.

3rd. A special set of experiments which I have had made, on reading Dr. Lunge's paper, partly with a view to find out the sources of error likely to occur, and to determine the accuracy of the process generally.

a. It was found that there was a danger of all the nitrogen compounds not being decomposed and driven off as ammonia in any given time, and the simple precaution against this source of error, of changing the receiver, and continuing the distillation for a short time further, is quite enough to prevent this error passing unobserved.

b. It was found that the decomposition took place most completely at the higher temperatures, and that it was necessary to evaporate until the contents of the flask were in a pasty condition, in order to get off the final traces of the NH_3.

c. The danger of fixed alkali or zincate of soda passing over even the wash flask was found to be a source of probable occasional error, and it was guarded against by neutralising the excess acid with standard soda, then adding a known excess and boiling until all the NH_3 had been expelled, when the solution is titrated with standard acid.

(To be continued.)

* *Chemical Society's Journal*, xv., p. 381.
† *Silliman's Journal*, April, 1877.
‡ *Chemical Society's Journal*, 1873, 541—549.

ESTIMATION OF THE TOTAL CARBON IN IRON AND STEEL *EN MASSE*.

By SYDNEY C. JUTSUM.

The author having had some experience in these analyses of their inherent difficulties and the best means of overcoming them, takes the present opportunity of laying them before the readers of the Chemical News, trusting they will prove of service to those who perform iron and steel analyses.

There are three principal methods employed for this purpose. 1st. Regnault's, or the direct combustion of the iron. 2nd. Berzelius's, or dissolving by means of $CuCl_2$ and subsequent oxidation of the separated C. 3rd. Weyl's, or the electrolytic solution of the metal and subsequent oxidation as in No. 2.—(*Pogg. Annal.*, 114, 507.)

1st. *Solution of the Metal.*—One is met at the outset by the following difficulties. Method No. 1 requires "the iron to be in the finest powder, and passed through a plate sieve with very small holes." ("Fresenius Quant. Anal.") Now there are many samples of metal which it is impossible even to file, and can only be cleaned by the grindstone; and the softer specimens are very liable to become mixed with foreign bodies when being pulverised and sieved.

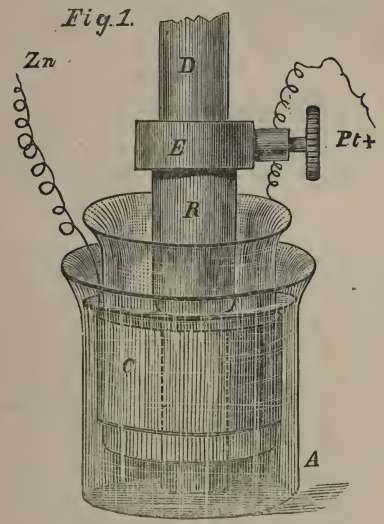
No. 2 method effects solution by means of the following mixture :—6 ozs. $CuSO_4$, 4 ozs. NaCl, 2 fl. ozs. HCl, and 20 ozs. water. In Fresenius's laboratory I saw NH_4Cl employed instead of NaCl. Both at King's College and Fresenius's laboratories I have seen 4 to 6 days required to dissolve 10 grms. of *soft iron turnings*. With the tool steel which I used for analysis this method was also inapplicable, because the metal was too hard even to file, and such a compact block of metal would have required

* *Zeitschr. Anal. Chem.*, xvi., 267, 314.

weeks—perhaps months—for solution. I therefore pointed out the two objections to these two methods, viz. :—1st, the impossibility of reducing the metal to "turnings" or chips, much less fine powder in many cases, and the danger to its purity even when attained; and, 2nd, the length of time required for solution. But I never received any satisfactory reply to these two main objections. In addition to the above objections, I may add the employment of free acid as in the above solution is dangerous, as it causes a loss of C in the form of gaseous hydrocarbons, more especially if the mixture is heated. (*Hahn Annal. d. Chemie. u. Pharm.*, 129, 76.) Without free acid the time is longer. Again, the precipitation of the metallic Cu is a drawback, causing waste of H_2SO_4 and CrO_3 in the subsequent part of the analysis (should Ullgren's method be employed to oxidise the C), or else an extra loss of time to effect its solution.

With the 3rd, or electrolytic method, none of these difficulties arise. 1st. There is no need to pulverise the metal; and, 2nd, the time is about one hour to effect solution of 10 to 15 grms. metal. I used to start it to work the last thing before leaving off work, which requires about one hour; it proceeds during the night by itself, and on arriving next morning one finds 10 to 15 grms. of the hardest tool steel dissolved and the C separated out in large flakes, and in an excellent condition for filtration. There are, however, a few simple precautions to be observed; this done the method works rapidly and accurately. A single Grove or Bunsen cell is employed, and a simple decomposing cell, which I found to answer very well, as represented in Fig. 1. A is a beaker of about

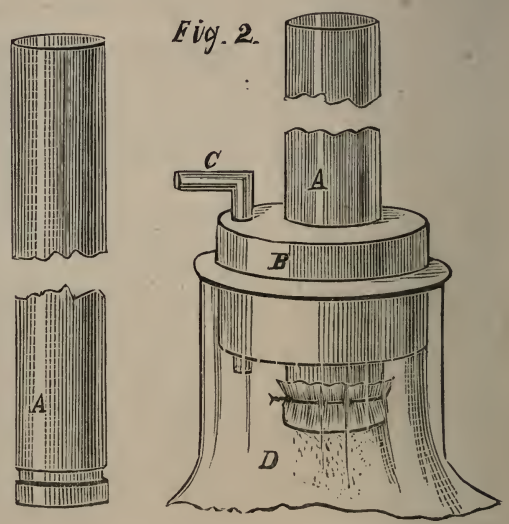
Fig. 1.



5 ozs. capacity containing HCl, in which is immersed a glass cylinder, B (a beaker without a bottom), and *between* them is a Pt foil connected with the negative electrode. The best strength for the HCl is sp. gr. 1050, or about 1 pt. HCl *conc.* and 3 water. Fresenius merely says "dilute" acid; but I found sp. gr. 1100 or 1 pt. HCl *conc.* to 1 water to be too strong, causing Cl to be evolved at the surface of the steel, and thus running a risk of loss of C. D is the steel bar, and E a common binding screw. The object of this cell is to see if any bubbles of Cl or gaseous hydrocarbons are given off at the surface of the steel, which would prove fatal to the success of the analysis, and which in an ordinary decomposing cell is not at all easy to ascertain on account of the violent evolution of H from the negative electrode. The steel bar is best preserved from rusting by a strip of rubber sheeting tied round it, leaving 1 inch exposed for solution, R, Fig. 1. Next comes the binding screw, E, for the purpose of connecting it with the battery, and the rest of the bar may be protected by a thermometer-case from the acid fumes. By these means I was enabled to preserve its brightness for two weeks. The bar I employed was 11 inches long by ¼ inch square. It was first *ground* bright, weighed, and immersed in the cell to a depth of about 1 inch. After solution it was again weighed; the loss represented the steel dissolved. With regard to the strength of the current, two-quart Daniell cells are too weak to overcome the resistance due to the liquid and counter current, and two Groves or Bunsen's are too strong, causing the evolution of gas at the surface of the steel. It is important to regulate these various factors, as otherwise the solution proceeds too slowly, and on arriving next morning the steel is not dissolved; or it proceeds too rapidly, and then ensues a loss of C. As before stated, one hour's work the last thing before leaving is all the time required to effect solution by this method when properly conducted, and the process proceeds and finishes by itself during the night.

2nd. *Filtration of the* C.—Of course filtering paper is inadmissible. It is recommended in the text-books to use an asbestos filter tube, but it is difficult to make them work satisfactorily. The C is often in very fine powder, especially when the method No. 2 is employed, and the filter is very liable to allow the C to run through or to choke. I tried pounded glass, glass wool, but with much the same effect, and have seen in the laboratories the results obtained by others. I have seen hours taken to filter and wash the C even when using a water pump. I have therefore invented a simple apparatus, which, while

Fig. 2.



it does not permit the finest particles of C to run through, at the same time allows the whole operation of filtering the contents of the decomposing cell, washing with soda, and lastly with water to be completed in 10 or 15 minutes. Fig. 2 represents the apparatus. A is a glass tube, about 12 inches long, 1 inch wide, and ⅛ inch thick in the walls. Half an inch from one end is filed a groove, E. The tube is inserted in a doubly-perforated stopper, B; the other perforation contains a tube connected with an exhausting pump, C. The stopper is inserted in a *thick* glass bottle, D. Over the end, E, of A is first placed a disc of *filtering paper* (the purpose of which will be explained further on) next a piece of *muslin*, and lastly a piece of wire gauze, the whole being securely wired on to the tube, the groove, E, preventing it slipping off. Into the tube, A, purified silver sand is next placed to a height of 1 inch, and upon that glass wool to the same height. On pouring the contents

of the decomposing cell into the tube, A, and exhausting, the entire contents were completely filtered and washed in ten minutes. It is important to wash first with water, then with caustic soda, and lastly with water, in order to ensure the complete removal of HCl, which if allowed to remain would give rise to Cl in the Ullgren's apparatus and increase the weight of the potash bulbs. The stopper, B, is then removed, the cap is then taken off the tube, and the contents are pushed into the flask of the Ullgren's apparatus by first inserting an extra plug of glass wool and pushing it down into the tube: the entire contents are thus completely removed. On examining the little disc of filtering paper no C is ever seen on it except a minute *brown* stain. This filter tube when carefully managed never allows the smallest particle of C to run through and never filters slowly, the liquid running out so rapidly as to even cause some little trouble to keep the tube full.

3rd. *Oxidation of the C.*—This can be easily done either in a combustion furnace or in the well-known Ullgren's apparatus with H_2SO_4 and CrO_3. I met with an unexpected difficulty, owing to the KHO containing potassic nitrite, which by absorbing the O increased the weight of the potash bulbs too much. Mr. G. S. Johnson was the first to point out this reason to me, as he had previously found the same impurity in caustic potash, and his results I confirmed by a long series of experiments, which, however, are not considered interesting enough for re-publication. Another source of error is the difficulty of obtaining a constant figure on removing, weighing, and re-attaching the potash bulbs to the apparatus. The difference, however, is small, and the general opinion seems to be that the CO_2 is absorbed into the interstices of the pumice, and is with difficulty dislodged.

In conclusion, I have to thank Prof. Bloxam for his great kindness in correcting this MS. and for superintending these analyses, and to Prof. W. N. Hartley for kindly giving me the benefit of his experience in iron and steel analyses.

NOTICES OF BOOKS.

Electro-plating. By J. W. Urquhart, C.E. Pp. vi. and 216. London: Crosby Lockwood and Co. 1880.

Had the chemistry of this small manual been sound, we could have commended it without reservation. The author is obviously more thoroughly familiar with the metallurgical workshop than with the chemical laboratory. He speaks (p. 40) of caustic lime as being "apt to absorb moisture, and swell," as if this were an occasional and rather undesirable quality of the compound in question. The impurities of cyanide of potassium are vaguely termed "salt of potash" (*loc. cit.*). Hydrocyanic acid is spoken of (p. 43) as a solution of "a gas called prussic acid." "Fumes of cyanogen" are said (p. 83) to escape from a mixture of cyanide of potassium and sulphate of copper. The descriptions of metallic mercury (p. 44) and of the tests for its quality waste ten lines of letterpress: the essential facts might have been stated in the same space, and in simple, perfectly intelligible, and useful form. We are introduced (p. 44) to the remarkable bit of commercial intelligence that nitric acid may be bought "in Worcester quarts at 25 per cent less." The directions as to the purchase of chemicals and apparatus seem inadequate, as in the following case (p. 46):—"A galvanometer is very useful; get one with two circuits." But when we turn from the introductory and explanatory portions of Mr. Urquhart's volume to the chapters on the actual operations of electro-metallurgy, we find instructions complete enough and clear enough for all ordinary work. But even this part of the volume might have been made more useful had it been more precise in details and more methodical in arrangement.

The author would have acted more judiciously had he refrained from attempting to include "all the necessary information concerning materials, the preparation of them, and their prices in commerce," in his small practical handbook on electro-plating and electrotyping.

Questions on Chemistry: a Series of Problems and Exercises. By F. Jones, F.R.S.E., F.C.S. London: Macmillan. 1879.

The author or collector of these 1237 problems and exercises prefaces his little book with no justificatory remarks. He has, no doubt, felt the want of a large and varied series of intelligent questions for his classes, and has not been satisfied with the problems to be met with in the usual chemical manuals. Certainly, from whatever source or sources they may have been derived, these questions on chemistry cannot fail to be of considerable service to teachers. They are numerous; they are judicious; they are interesting, and they are often in themselves instructive. A characteristic specimen is No. 190, p. 30:—"The Koh-i-noor diamond weighs 106 carat (1 carat = 3·17 grains). What volume of oxygen at N.T.P. would be necessary to burn it, and what volume of carbon dioxide would result?" A large proportion of the questions are so turned as to discourage cram: with the same intention it would be well to introduce others beginning with "Describe the compound represented by the formula so-and-so;" "Complete the following equations," and so forth.

First Book of Qualitative Chemistry. By A. B. Prescott. Pp. 160. New York: D. van Nostrand. London: Trübner. 1879.

As we cannot produce a sufficient number and variety o small chemical text-books in this country the Americans are sharing in the manufacture. We confess that we long for some one chemist, with wide and intimate experience of teaching, and profound knowledge of the science, to take in hand the task of gathering every meritorious feature of these innumerable manuals of qualitative analysis into one focus. Of course a large number of these books possess no distinguishing characteristics worth preserving, but are mere compilations, chiefly for cram purposes, written by teachers with scant knowledge and limited experience. But Professor Prescott's "First Book" belongs to a quite different class, and yet it is difficult to understand what special necessity could have determined the author to add another manual to the score of useful works previously in existence. True, we have here an elementary book introductory to larger treatises; and a clearly-written book, giving hints, notes, suggestions, explanations, and illustrations, both varied and apposite. True, we have here presented in an instructive form a more definite and detailed study of bases and acids than is usually comprised in ordinary courses of experimental chemistry. But, with all its merits, and they are many, this book exhibits more ingenuity in its course of analysis and tabular arrangements than accuracy in its details. We constantly come upon erroneous formulæ. White-lead, for instance, is not $Pb_3H_2O_2(CO_2)_2$, as stated on page 21; gypsum is not $CaSO_4H_2O$ (p. 42); cassiterite is not stannous oxide (p. 96). But if such blemishes were removed we should possess in this elementary manual a very concise, compact, and methodical arrangement of a course of qualitative analysis. The best features of the work are these two—extreme lucidity in the descriptions given of the courses of analytical operations, and extreme thoroughness in the explanations of the chemical changes mentioned or employed. The Americanisms in expression, grammar, and spelling, are peculiarities which may easily be condoned in view of the excellent qualities which we have named. In fact, the only substantial

questions relate to the utility of this volume. Was it needed at all? Does it supply a real want? Have we not already at least half-a-dozen manuals of qualitative analysis covering the same ground, and answering the same purpose as Prof. Prescott's "First Book"? However, the circumstances and aims of different teachers, and of different students, vary so much that we feel that it would not be wise to give perfectly definite answers to the questions which we have just propounded. For a time, at least, room may be found, and a sphere of usefulness, for the book before us.

Annals of Chemical Medicine, including the Application of Chemistry to Physiology, Pathology, Therapeutics, Pharmacy, Toxicology, and Hygiene. Vol. I. Edited by J. L. W. Thudichum, M.D. London: Longmans, Green, and Co.

We have here the first volume of a new periodical devoted in the main to those subjects where chemistry and biology come in contact, and form, like most border-regions, a fruitful field for investigation. In his preface the author refers to the manner in which his researches, scattered through various journals and *Transactions*, have been at once ignored and pirated. To this subject he returns in a chapter on biliary pigments, in which Profs. Maly and Hoppe-Seyler are somewhat sharply criticised.

In another portion of the work he discusses the colouring matter in the shells of birds' eggs as "an illustration of chemical diagnosis at a glance, and of the value of abstract chemical researches." He criticises the views of Wicke, Sorby, and Liebermann, maintains that the green pigment of egg-shells is similar to but not identical with biliverdin, and that the colouring matters are not painted on the outside of the shell, but imbedded in its substance. Diagrams are given of the spectra of cruentin, a derivative of hemato-crystallin and of hematin, from which latter substance it is obtained by treatment with sulphuric acid.

A long but interesting chapter is devoted to an account of the life and philosophy of Robert Julius Mayer, the joint discoverer with Joule of the mechanical equivalent of heat, and hence substantially of the doctrine of the conservation of energy. It almost takes away one's breath to learn that the subject of this memoir was sentenced to "rustication" (*i.e.*, received the *consilium abeundi*) by the University of Tübingen on the charge of "having been at a ball of the casino in a frock coat instead of the obligatory dress coat!" This is a very curious specimen of "*akademische Freikeit*." Save at the conclusion of his career, Mayer was so little appreciated that he might almost claim a place among the martyrs of science. We must admit that his great excitability, which in the latter part of his life was manifested in occasional attacks of actual insanity, and his general peculiarity of character and of style contributed greatly to prevent, or at least retard, the recognition of his views among the scientific world. But making all due allowances for such hindrances, we cannot help perceiving that it is still possible, even in Germany, for a discovery of the first order to be kept in the background by the machinations of jealous cliques whose spirit is very much on a par with that of trades-unionism. Among his opponents Dr. Seyffer might almost be characterised as a modern edition of Caccini or Riolan. But justice, tardy, indeed, but still complete, has been rendered to Mayer, and those who in our days are inclined to enter seriously upon the study of physics are now told that they cannot do better than begin with his works.

Dr. Thudichum devotes a chapter to combatting the existence of protagon as a chemical individual. He remarks that "the uniform chemical composition of the brain greatly favours the obtaining from it by the aid of processes nearly akin to trimming, of extracts of uniform composition; this uniformity can be greatly aided by limitations of the quantities of materials operated upon, and of the quantities and strengths of the solvents, and by careful observation of these limitations, preparations are obtained which present a delusive appearance of definiteness."

The chapters on infection and infectious matter, and on the conflicting views of contagionists and non-contagionists concerning the origin of diphtheria, are an excellent summary of modern theories on these subjects. Altogether this volume is replete with valuable matter in one of the most difficult and neglected fields of chemistry. The author's occasional bitterness we can well understand when we find that some of the faculty propound inaccurate methods with the singular excuse that they are "good enough for clinical purposes." When shall we all learn that scientific work, unless accurately done, had much better not be done at all?

Photographic Printers' Assistant. By William Heighman, author of "Practical Portrait Photography," &c. London: Richardson and Best. 1879.

Mr. Heighman is well known as one of our most practical writers on photography, and he has done well to bring together in one little book a mass of valuable information with regard to the various printing processes. It is now some years since the art of photography underwent a process of self-division, and the worker with the camera rarely touches the printing frame, and *vice versa*. The processes described include paper printing in all its varieties and printing on porcelain. The sensitising and turning rooms, and their various appliances, also receive minute attention. The chapters on the treatment of disordered baths are also excellent. We are glad to see that Mr. Heighman does not confuse his pupil with too many formulæ. He might, however, with advantage have given more directions for the treatment of photographic waste.

Studies on Fermentation, the Diseases of Beer, their Causes, and the Means of Preventing Them. By L. Pasteur, F.R.S., Member of the Academy of Sciences. A translation, made with the author's sanction, of "Etudes sur la Bière." By Frank Faulkner and D. Constable Robb. London: Macmillan and Co.

In examining works rendered from some foreign language we generally find ourselves face to face with two persons only, the author and the translator, and can easily apportion their shares of responsibility. Here the task is more difficult. There has been, in the first place, a literal version of Pasteur's work, executed by Mr. F. U. Waite. Then comes in Mr. D. C. Robb, who, "taking Mr. Waite's version as a basis, has so elaborated, annotated, and recast it," that the editor, Mr. Faulkner, feels bound to say that much of the value of the work, as it now appears, is due to this process of revision. This is somewhat perplexing. "Annotation" is at once intelligible, but "elaboration and recasting" seem to us to imply either additions to or modifications of the original subject matter. Not having the opportunity of comparing this edition with the French original, we are therefore at a loss to know whether it is M. Pasteur or Mr. Robb who speaks.

The change of title we hold to be an improvement. Under the name "Studies on Beer" it would have been read by brewers alone, and by that small and perfect distinct class of chemists who have made the theory of brewing their speciality. For us it would have had little attraction, since, though we by no means endorse the views advocated by Dr. Richardson and other eminent medical practitioners, that fermented beverages are altogether an evil, yet we cannot see, without regret, a highly nitrogenous product like grain used for the manufacture of a non-nitrogenous compound such as alcohol.

But M. Pasteur's work is not a mere trade manual. It enters into the question of so-called spontaneous generation (abiogenesis), it expounds the new, or physiological,

theory of fermentation, and throws valuable side-l ghts upon the origin and propagation of a formidable class of diseases—the zymotic, or pestilential. The theories of M. Trécul, M. Fremy, M. Béchamp, of Liebig, Oscar Brefeld, and Moritz Traube are also reviewed and combatted at some length.

M. Pasteur's own view, in brief, is that every kind of fermentation is due to the action of some organism pre-existent, and introduced into the fermentible liquid from without; such liquids, *e.g.*, grape-juice if protected with sufficient care, will not undergo fermentation—that each kind of fermentation, such as the alcoholic, the acetic, the lactic, &c., is due to a specific ferment; that each such ferment is a true and distinct vegetable species, reproducing its own kind, and that the various diseases, so-called, of wine, and especially of beer, are due to the presence of ferment germs or organisms other than those which effect the splitting up of sugar into alcohol. These propositions he has supported with such a bulk of experimental evidence that so far as we can see at present they must be accepted as in accordance with facts.

The practical conclusions drawn are that it is essential for every brewer, and indeed for every manufacturer of fermented liquids, to learn to distinguish between the ferments which serve his purpose and those which fight against him and destroy his products, and that he should be acquainted with the circumstances which favour the development of the one or the other class. This knowledge will enable him to understand and to prevent much loss which is now quietly accepted as accidental, mysterious, and therefore not to be remedied. Such knowledge the work before us supplies, or at least shows how it may be acquired.

The author shows, however, that the fermentative power is not peculiar to cells of a special nature, but depends on external circumstances and on the nutritive condition of the organism; in short, fermentation is the consequence of a peculiar vital process of nutrition which occurs under certain conditions. M. Pasteur, indeed, considers that the fermentative character may belong to every animal or vegetable cell on the condition that the acts of assimilation and excretion must be capable of taking place in such cell for a brief period without the necessity for recourse to supplies of atmospheric oxygen. In other words, an anærobian cell is a ferment cell. This generalised view of fermentation is supported by actual experiments on grapes, plums, &c., which, on immersion in carbonic acid gas, lost sugar and generated alcohol, though no ordinary yeast cells were present. These facts have been observed not only by M. Pasteur and M. Dumas, but by MM. Lechartier and Bellamy whilst engaged in researches on the ripening of fruits. Fruits, then, when surrounded with air live in their ærobian state, and there is no fermentation, but if immersed in carbonic acid they assume the anærobian state, and at once produce alcohol. These experimental results, it may here be remarked, are not favourable to the views of those who assert that alcohol is an unnatural product. If a heap of fruits be thrown together its production is an exceedingly probable reaction, and that in the entire absence of any human purpose or contrivance.

It is sometimes insinuated that M. Pasteur's conclusions are inimical to the theory of Organic Evolution. That they do not harmonise with abiogenesis we admit, but what can be said to the following passage:—"What was the nature of their original germs? (*i.e.*, of 'high' and 'low' ferments). These are questions which we are unable to answer, but we are very much inclined to think that we have here another example of the modifications which plants as well as races of animals undergo."

Turning to a very different subject we think that most Englishmen will totally dissent from the opinion repeatedly expressed in this work that malt liquors prepared by top fermentation are necessarily and universally inferior in flavour to those which, like the Bavarian beers, are made by "bottom" and "low" fermentation. That very deplorable beers have been made on the Continent by "top" fermentation is no argument against English and Scotch ales. We might as well condemn the choicest wines of France, Greece, or Hungary because the juice of the grape at Gruenberg yields a beverage which we can only pronounce excruciating.

But though this work will not—and in our opinion *should* not—induce our English brewers to revolutionise their whole system, it will doubtless suggest to them improvements of unquestionable value, and be the means of preventing great and frequent losses. It must therefore be pronounced a valuable contribution to our scientific and technical literature.

The Chemists' and Druggists' Diary for 1880. 44a, Cannon-street, E.C. 1880.

Letts and Co.'s Diaries for 1880. Letts and Co. 1880.

The "Chemists' and Druggists' Diary," in addition to the usual trade notes and memoranda, contains a novel feature in the form of a well-written article, extending over twelve closely-printed quarto pages, on the art of dispensing, the work of several different authors, each of them specially conversant with some particular branch of the subject. Contributions have also been levied on the well-known works of Procter, Parrish, and Lescher, the *Pharmaceutical Journal*, and the *Chemist and Druggist*. We consequently have, so to speak, an eclectic essay on this important subject. The article seems very ably put together, and its general style presupposes a high standard of scientific education on the part of the student. The other articles are on the "Price of Medicines," by the late Daniel Hanbury, "Copyright in Designs," "Saturation Tables," Abbreviations, and French and German words used in prescriptions, and a Posological Table. By the way, in glancing over the table of Abbreviations used in Prescriptions we find that "A" has eight different meanings, "M" eleven, "P" twelve, and "S" no less than fifteen. Surely the sooner such abbreviations are entirely done away with the less chance will there be of physicians' prescriptions becoming possible death warrants.

We have received our usual yearly batch of Letts's useful Diaries for 1880. Having reached their thirtieth year there seems to be little more to say of them than that they still keep up their old high standard of excellence and as ingenious machines for diminishing loss of time and temper, some of them at least ought to be in the hands of every man of business, professional or otherwise. The octavo edition, No. 8, containing one page to each day, seems to be one of the most convenient for laboratory use.

CORRESPONDENCE.

OXIDISING VALUE OF CHLORATE AND OF BICHROMATE OF POTASH.

To the Editor of the Chemical News.

Sir,—With reference to the present high price of bichromate of potash, I think that many of the consumers of this article may have overlooked the fact that as an oxidising agent chlorate potash is now relatively much cheaper than bichrome. Chlorate of potash is now worth only about 8d. per pound; bichromate of potash has advanced to 7d. per pound. The relative oxidising power is, however, enormously in favour of chlorate. In round figures, one pound of chlorate will do the work of two and a half pounds of bichrome; at the above mentioned prices chlorate of potash as an oxidising agent is less than half the cost of bichrome.

Two years ago these two articles were relatively very nearly at the same price, viz., chlorate at about 9d. per pound and bichromate of potash about 4½d. per pound. For many oxidising purposes chlorate could actually be substituted with advantage for bichrome; after oxidisation the residue is simply chloride of potassium, a soluble colourless salt. Bichrome leaves the insoluble dark coloured sesquioxide of chromium, which in some operations is removed with difficulty. It may also interest some of your manufacturing readers to note that, even as compared with the cheapest commercial oxidising agent—bleaching-powder—chlorate of potash is much lower than it has ever been before, and though not actually so cheap yet the relative cost of the two articles as oxidising agents now approaches each other pretty closely.—I am, &c.,

W. J. Menzies, Managing Director.

Greenbank Alkali Works, St. Helens, Lancashire.

THE BLUE FLAME IN COAL FIRES.

To the Editor of the Chemical News.

Sir,—A year or two ago some correspondence occurred in *Nature* as to the cause of the blue flame observable in coal fires, which some of the editor's correspondents attributed to chloride of copper, others to sulphur, &c.

May I be permitted to add a suggestion to the above mentioned ingenious hypotheses, that the blue flame may be nothing but *Bunsenised* coal gas.

The flames, which are yellow and luminous when coals are first placed on a fire, become gradually thin, non-luminous, and bluish, when (as is here supposed) the bituminous matter having been consumed, the sides and bottom of the coal, or rather coke, have become porous, permitting the in-draught of air to mix with the burning gases at top, which are thus Bunsenised.—I am, &c.,

W. A. Ross.

London, W., January 3rd, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 24, December 15, 1879.

Researches on the so-called Hydride of Copper. M. Berthelot.—The author concludes that the amorphous substance precipitated in the reaction of hypophosphorous acid and sulphate of copper is not a true hydride, but a sort of phosphated hydroxide of copper, perhaps a mixture of several compounds.

Observations on the Cold supported by certain Microscopic Organisms.—M. Pasteur.—The bacteria of carbuncle and the organism producing the so-called cholera of poultry can bear temperatures of −40° without losing either virulence or their power of multiplication.

Measurement of the Intensity of the Rays of Absorption and of the Dark Rays of the Solar Spectrum.—M. Gouy.—Not susceptible of useful abstraction.

Chemical Composition of the Bones in the Arthropathy of Ataxic Cases.—P. Regnard.—In these bones the total mineral matter was found to be only 24·20 per cent, whilst the phosphates of lime and magnesia were reduced to 11·6. Of the organic matter 37·70 per cent or nearly one-half was fat.

No. 25, December 22, 1879.

Reply to M. Berthelot's Researches on so-called Copper Hydride.—A. Wurtz.—The author seeks to maintain the definite character of the compound Cu_2H_2.

Reply to the Remarks of M. H. Sainte-Claire Deville on the Temperature of the Decomposition of Vapours.—A. Wurtz.—The author maintains that the vapour of chloral hydrate is not a compound, but a mixture, because it diffuses itself like a mixture of watery vapour and of anhydrous chloral; because, on ebullition, hydrated chloral is resolved into watery vapour and anhydrous chloral, which may be separated by means of chloroform, or by fractionated distillation; because the vapour of chloral hydrate behaves with a hydrated or anhydrous salt, like a mixture containing watery vapour; and, lastly, because the two vapours may meet without giving rise to the slightest disengagement of heat.

A New Silicium Hydride.—J. Ogier.—(See p. 1).

Comparative Researches on Pytalin and Diastase.—Th. Defresne.—The action of the saliva is arrested by *pure* gastric juice; but, on the other hand, if we operate with mixed gastric juice, containing merely organic acids, the saccharification of starch proceeds as well as in the mouth. Pytalin and diastase are, therefore, not physiologically identical, since the saccharifying action of the latter is irrecoverably destroyed by pure gastric juice or by hydrochloric solutions, and even after contact with mixed gastric juice, though it still dissolves starch, it no longer saccharifies.

A New Capillary Electrometer.—E. Debrun.—The instrument is a modification of the electrometer of Lipmann.

Determination of the Elements of a Vibratory Movement: Measurement of the Periods.—E. Mercadier.—A mathematical paper, not susceptible of useful abstraction.

Researches on Nitrification.—MM. Schlœsing and Muntz.—Nitrification is effected within well-marked limits of temperature. Below 5° it is exceedingly feeble, if not entirely annulled, becomes appreciable at 12°, reaches its maximum at 37°, and then declines. At 45° the formation is less than at 15°, and above 55° there is no longer a trace. Nitrification increases with the proportion of the moisture, so long as the free circulation of air among the particles of the soil or other medium is not arrested. A slightly alkaline state of the medium is also necessary, due generally in nature to the presence of the bicarbonate of lime. Alkaline carbonates have the same effect if very dilute, but if they exceed 2 or 3 parts in the thousand they become unfavourable and even arrest nitrification. The presence of small quantities of neutral salts of the alkalies or alkaline earths appears to have no influence. Organic substances seem to act by affording a carbonaceous pabulum for the nitric ferment. The formation of nitrites is frequent in a liquid medium, especially if the thickness of the stratum exceeds 2 m.m. In soils nitrites are rarely produced.

Di-oxy-ethyl-methylen and the Preparation of Methylen Chloride.—W. H. Greene.—Di-oxy-ethyl-methylenic ether possesses a strong and pleasant odour; its sp. gr. is 0·851, and it boils at 89°. It is slightly soluble in water, from which it may be separated by means of calcic chloride. It dissolves in all proportions in alcohol and ether.

Palmellin and Characin, extracted from Fresh-water Algæ.—T. L. Phipson.—The yellow colouring-matter extracted from *Palmella cruenta* proves to be xanthophyll. Chlorophyll is also present as well as palmellin and characin. The latter substance is a kind of camphor, white, unctuous, volatile, inflammable, non-saponifiable, soluble in alcohol and ether, but almost insoluble in water.

Justus Liebig's Annalen der Chemie, Band 199, Heft 2 and 3.

Contributions to the History of Starch and of its Transformations.—H. T. Brown and J. Heron.—After

a survey of the results obtained by former experimentalists, the authors describe the methods they have used for the purification of starch, for the preparation of starch-paste, and the preparation and analysis of the extract of malt, and the analysis of the transformation products of starch. They then examine the behaviour of starch with the extract of malt, after a preliminary notice of the changes undergone by a cold infusion of the latter, its fermentation in the cold, and its behaviour when heated. They find that the invertive action of the malt-ferment is most powerful about 55°, and ceases to act almost entirely at 66°. They then turn to the nature and properties of starch and starch-cellulose, the transformation of the insoluble cellulose, and the separation of a second body. They treat of the different glutinosity of starch-paste as occasioned by very slight differences in the manufacture of the starch. They describe the sp. gr. of starch in the form of paste, the solubility of granulose, the optical activity of starch-paste, its behaviour with potassa; the properties of maltose, its reaction with dilute sulphuric acid and with extract of malt; the behaviour of the latter with starch, distinguishing the various kinds of grain; the action of extract of malt upon bruised starch, upon starch-paste in the cold, describing the reaction as rapid and energetic; the behaviour of malt-extract upon starch-paste in heat at a number of specified temperatures. They then treat of the detection of soluble starch or achroodextrin in presence of erythrodextrin; the influence of neutralisation upon the activity of extract of malt, the molecular transformations of starch. They examine if dextrose is a product of the action of malt-extract upon starch, and reply in the negative, the product formed being maltose. Finally they discuss the nature of diastase.

Certain Ultramarine Compounds.—K. Heumann.—The author concludes that in a successful operation in a sealed tube, the reaction of silver nitrate upon blue sodium ultramarine is a very complete substitution of the sodium by an equivalent weight of silver, the subsidiary reactions being so trifling that they may be overlooked. The yellow silver ultramarine is beyond doubt a silver compound, corresponding to the blue sodium ultramarine. The author considers that a quantitative study of the various reactions of silver ultramarine will be of great value for throwing a light on the nature of the ultramarine compounds.

Hydrazin Compounds.—E. Fischer.—In this, his second memoir on the subject, the author describes the hydrazin compounds of the fatty series.

Ethyl Derivatives of Phenyl-hydrazin.—E. Fischer and W. Ehrhardt.—A description of diethyl-diphenyl-tetrazon, of azo-phenyl-ethyl, of hydrazo-phenyl-ethyl, and of the oxidation of phenyl-hydrazin by mercuric oxide.

Composition and Optical Behaviour of Quinamin.—O. Hesse.—The author's formula is $C_{12}H_{24}N_2O_2$.

Californian Orchella Weed.—O. Hesse.—The weed in question contains merely erythrin, along with very small quantities of roccellic acid as chromogen.

Amido-methylen-pyrocatechins.—O. Hesse.—The author obtains the hydrochlorate of monamido-methylen-pyrocatechin by the action of tin-filings and hydrochloric acid upon nitro-piperonylic acid.

On Quinin.—Z. H. Skraup.—The author considers that a methoxyl group is present in quinin, which occasions the production of formic acid. There are also grounds for assuming the existence in quinin of a hydroxyl group.

On Homo-cinchonidin.—Z. H. Skraup.—Homo-cinchonidin is struck out of the list of chemical individuals.

Annales de la Société des Sciences Industrielles de Lyon.
1879.

This volume contains nothing relating to the industrial applications of chemistry.

Revue Universelle des Mines, de la Metallurgie, &c.,
Tome 6, No. 1, July and August, 1879.

Determination of Carbonic Anhydride.—A. Classen and V. Francken.—The process cannot be intelligibly described without the accompanying plate.

Journal für Praktische Chemie.
No. 19 and 20.

Decomposition of Albumen in the Sprouts of Pumpkins.—E. Schulze and J. Barbieri.—Ferments probably take no part in the splitting up of albuminoid substances which takes place in protoplasm. Nägeli doubts if the organism ever forms ferments to act within the plasma.

Behaviour of Arseniferous Bismuth with Nitric Acid, and Preparation of Basic Bismuth Nitrate free from Arsenic.—R. Schneider.—If nitric acid acts upon arseniferous bismuth at a low temperature, the arsenic is oxidised to arsenious acid. But as bismuth arsenite is readily soluble in nitric acid, the liquid remains clear. If the temperature is allowed to rise, arsenic acid is generated, with the production of bismuth arseniate, very sparingly soluble in nitric acid.

Vitality of Schizomycetes in the Absence of Oxygen.—J. W. Gunning.—A reply to Nencki's defence of Pasteur's theory of anærobiosis.

Chemical Composition of the Bacteria of Putrefaction.—M. Nencki and F. Schaffer.—As in yeast, so in putrefactive bacteria, the layers which form cellular membrane do not consist entirely of a body resembling cellulose. An albuminoid matter is a constant element of their membranes.

Empirical Formula of Scatol.—M. Nencki.—The author gives this formula as $C_9H_9N.C_6H_2(NO_2)_3OH$.

On Urea-palladious Chloride.—E. Drechsel.—This compound is formed by adding to a solution of urea an aqueous or hydrochloric solution of palladious chloride. Its composition is $PdCl_2+2CN_2H_4O$.

The Source of Hippuric Acid in the Urine of the Herbivora.—O. Loew.—The author considers that in the grasses, in dandelion, &c., there exists an insoluble body which readily passes into quinic acid by hydration. The conversion of this acid into hippuric acid within the organism has been already observed.

Annales de Chimie et de Physique,
November, 1879.

The Instruments of Lavoisier.—M. Truchot.—A lengthy paper with many illustrations.

Action of Metallic Nitrates upon Monohydrated Nitric Acid.—M. A. Ditte.—The metallic nitrates may be divided into three distinct classes; those which dissolve largely in the acid and combine with it to form definite acid salts; those which, after having been deprived of their crystalline water, readily dissolve in the fuming acid, their solubility increasing with the temperature; and a third and more numerous class, which at all temperatures are insoluble, or nearly so, in the acid.

Formation-heat of Cyanogen.—M. Berthelot.—Already noticed.

On the Existence of Copper in Rocks, Seas, &c.—M. L. Dieulefait.—Already noticed.

Direct Combination of Cyanogen with Hydrogen and the Metals.—M. Berthelot.—Already noticed.

Various Thermo-chemical Data.—M. Berthelot.—Already noticed.

Action of Organic Solvents upon Sulphur and Metallic Sulphides.—M. Berthelot.—The author has dissolved powdered sulphur in pure ether and in "petro-

leum ethers," and has obtained similar results with natural sulphides, such as pyrrhotin, and with artificial ferrous sulphide.

On the Slow Changes of Wine During its Preservation.—M. Berthelot.

Galvanic Oxidation of Gold.—M. Berthelot.—Already noticed.

Decomposition of Hydroselenic Acid by Mercury.—M. Berthelot.—Already noticed.

Vibratory Forms of the Bubbles of Glyceric Liquid.—M. C. Decharme.—Already noticed.

Journal de Pharmacie et de Chimie.
December, 1879.

Mode of Action of Substances Employed in the Antiseptic Dressing of Wounds.—MM. Gosselin and Bergeron.—The authors ascribe the beneficial action of these dressings not merely to the destruction of ferments, but to the coagulation of the albumen.

Earthy Tritungstates.—M. Jules Lefort.—The author describes the tritungstates of barium, strontium, calcium, magnesium, aluminium, and also certain metallic tritungstates; those of manganese, iron, chrome, nickel, cobalt, and cadmiun.

The Alkaloids of the Cinchonas.—M. Jungfleisch.—An account of anhydrous quinine and of several of its hydrates.

Poisonous Properties of Phenol.—Dr. Binnendijk.—This acid acts in a direct manner upon the cerebro-spinal nervous system, and especially upon the respiratory centre, and is not without influence upon the blood. It is partly transformed in the organism, yielding hydroquinon, pyrocatechin, &c. A portion of the phenol seems to be oxidised.

Moniteur Scientifique, Quesneville.
December, 1879.

New Violet Colouring Matter.—M. Prud'homme.—The compound in question, known in commerce as "soluble violet," or "anthracen violet," is closely analogous to gallein, but is distinguished by its non-transformation into cœrulein, its resistance to boiling soap-lye upon tissues mordanted with iron and alumina, and its greater permanence when exposed to light. It contains no nitrogen, and is probably a substitution-derivative of gallein.

Account of Foreign Chemical Researches.—M. E. Nœlting.—Abstracts from the *Berichte der Deutschen Chem. Gesell.*

The Alkaloids of the Aconites.—Dr. Alder Wright and A. P. Luff.—From the *Journal of the Chemical Society.*

Experimental Possibility of the Dissociation of the Non-Metallic Elements.—M. Raoul Pictet.—After a number of important preliminary considerations, the reader is referred to the author's original memoir published in the *Archives des Sciences Physiques et Naturelles de Genève*, October 15th, 1879.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.
No. 71, November, 1879.

Report by M. de Luynes on a Pallet for the Assay of Oils by MM. Dufour and Ronaix.—The authors use the well-known reagents, such as sulphuric or nitric acids of suitable strengths, or a mixture of these two acids, or metallic nitrates, or nitrous acid along with the nitric acid. The sole novelty in the procedure is the method of applying these tests. They have constructed a rectangular pallet, white porcelain, in which are reserved cavities 5 millimetres in depth and 4 centimetres in diameter. The flat parts of the pallet are black, so that the double range of cavities appear in white on a black ground, which makes the observation of the colours more easy. To assay oils, into each cavity are poured twenty drops of the oil, which fills them all to the same level. Then upon the oil and in the centre of each cavity are poured 8 drops of the acid liquid. In the course of eight or ten minutes, and at the temperature of 15° to 25°, the peculiar colouration of each oil shows itself.

Memoir on the Destruction of Burrs in Wool.—M. René Leblanc.—The author describes all the known methods for this purpose, even giving a list of patents taken. He prefers dry hydrochloric acid gas, aluminium chloride, and acid phosphate of lime, and safer in their action than free liquid acids, however diluted. He then proposes a method of his own: the wool is to be thoroughly dried before being freed from the grease, to be passed in that state under heavy rollers which crush the burrs, and then treated in the ordinary manner.

Die Chemische Industrie.
No. 11, November, 1879.

This issue is chiefly taken up with an account of a congress on the German patent laws.

Chemiker Zeitung.
No. 51.

On Vanillin.—MM. Haarmann and Reimer.—An ethereal extract of vanillin, whether obtained from vanilla pods or the oxidation product of coniferin, if shaken up with a solution of sodium bisulphite, yields up its vanillin to the latter, exactly as in the case with the other aldehyds. The compound of vanillin with the bisulphite is then destroyed by the addition of sulphuric acid, and the pure vanillin is withdrawn from the liquid by agitation with ether. In this manner the actual vanillin, either in the natural pods or in artificial samples, may be accurately determined. The authors maintain that their artificial vanillin is chemically and physically identical with the natural product.

On Crystalline Calcium Fluoride. — Prof. Franz Stolba.—The author prepares the crude salt by heating in a flask on the water-bath an intimate mixture of three parts elutriated fluor-spar and one part of finely ground infusorial earth, covered with a mixture of seven parts crude hydrochloric acid and three parts water, and allows them to re-act for an hour. Calcium chloride is produced along with a solution of calcium silico-fluoride, from which the crystals are deposited on evaporation.

Volumetric Determination of Sulphuric Acid in Sulphates.—Dr. H. Precht.—The process of Wildenstein consisted in precipitating neutral solutions of sulphates with barium chloride, and detecting the end of the reaction by means of potassium chromate, whose yellow colour disappears owing to the formation of barium chromate as soon as all the sulphuric acid has been precipitated. Precht modifies this process by using an excess of barium chloride, precipitating with excess of potassium chromate, and determining the excess of the latter by means of a solution of a ferrous salt. To the liquid precipitated with normal barium chloride (104 grms. anhydrous salt in 1 litre) are added 10 c.c. potassium chromate of such a strength that 2 volumes correspond to 1 volume of the barium chloride); soda lye is added till the red colour turns to a yellow, the solution is cooled, and a little more potassium chromate is added, the half-litre flask is filled, and 1 part of the filtrate is titrated with ferrous sulphate

in presence of free sulphurous acid. The final reaction—the change of the colour—is distinctly perceptible, and is observed by placing a drop of the liquid upon a porcelain plate and touching it with a drop of solution of potassic ferricyanide till the blue colouration appears.—*Zeitschrift Anal. Chemie*, xviii., 521.

Modification of the Determination of Nitrogen by Dumas. — B. Reinitzer.—Requires the accompanying engraving. (See *Bericht. Oesterr. Gesell. Foerder Chem. Industrie*, i., 36.

The Electrolytic Determination of Cobalt, Nickel, and Copper, and its Advantages. — W. Ohl.—The author points out the sources of error and the tediousness unavoidable in the quantitative determination of these metals. He describes the small dynamo-electric Gramme machine which he employs, in default of which a Meidinger-Pinkus battery with superimposed flasks (each holding 5 kilos. sulphate of copper) may serve. In the determination of copper the needle of an interposed sinus-compass should diverge from 35 to 40, for samples of nickel 45 to 50, and for rich cobalt solutions 60 and upwards.—*Zeitschrift Anal. Chemie*, xviii., 521.

Platinum Attacked by Melting Alkaline Carbonates. —Dr. L. de Koninck.—A platinum crucible during the fusion of 6 grms. sodium potassium carbonate over a Bunsen burner and then over a blast-lamp lost 1 m.g., and on the addition of 1 grm. artificial manganese peroxide there was a further loss of 1·7 m.g. 23 grms. sodium potassium carbonate melted over a blast for 15 minutes withdrew 3·8 m.g. from the crucible. The fused mass was grey, yielding a yellowish solution, and contained exactly as much platinum as the crucible had lost.—*Zeitschrift Anal. Chemie*, xviii., 569.

Examination of Mineral Lubricating Oils.—Dr. Oscar Brenken.—The author determines :—1, the specific gravity ; 2, the temperature at which inflammable and continuously combustible gases are evolved. For this purpose he heats the oil on the sand-bath in a crucible 6·4 c.m. wide and 4·7 in depth, filled to 1·2 c.m. from its edge, and after the experimental temperature has been attained he removes it from the sand-bath and passes a small gas flame over it, as in Hannemann's petroleum-test, trying it first from 5 to 5 degrees and afterwards from 2 to 2. Oils which foam strongly when heated are unfit for many purposes. He observes, further :—3, the point of congelation ; 4, the undissolved constituents on dissolving 10 c.c. in an equal vol. of ether, filtering and weighing the washed residue ; 5, the reaction with soda-lye of sp. gr. 1·40 ; 10 c.c. of the oil are well shaken up with 5 c.c. of the soda-lye and heated in the boiling water-bath. After repeated shaking the lye must remain clear, and its volume must not be altered. The test-tube used in this experiment must be absolutely free from grease ; 6, the reaction with nitric acid of sp. gr. 1·45 ; on agitating equal volumes no rise of temperature, or but a very slight one, should be perceptible. This test shows the absence of tar-oils ; 7, reaction with sulphuric acid, sp. gr. 1·53 ; equal volumes are shaken up and heated in the water-bath, when the acid should take merely a pale-yellow colour. A brown or black colouration shows imperfect refining, or, along with No. 6, the presence of tarry oils; 8, behaviour on shaking with water; the water must remain clear, free from a whitish turbidity, and should not have an acid reaction.—*Zeitschrift Anal. Chemie*, xviii., 546.

Presence of Alcohols in Unfermented Fruit-juices. —Dr. Gutzeit.—The author extracted the unripe fruits of *Heracleum giganteum* with ether free from alcohol. In the watery stratum of the extract free ethylic and methylic alcohol were detected. In the ethereal stratum was found butyric-ethyl-ester along with solid hydrocarbons of the formula $C_n H_{2n}$.—*Jena Zeitschrift Naturw.*, xiii., 1.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 13, November 27, 1879.

Properties of the Gum of the Euphorbiaceæ.—Certain Euphorbiaceous plants growing in Natal yield a gummy matter, which if dissolved in alcohol and applied to metallic objects preserves them from the corrosive action of the sea or of brackish waters. It also secures articles of wood, &c., from the ravages of the white ants.

Superficial Viscosity of Liquids.—J. Plateau.—Continued from *Les Mondes*, Nov. 13 and 20.

No. 14, December 4, 1879.

This number contains no chemical matter which has not already appeared elsewhere.

No. 15, December 11, 1879.

Electro-magnetic Rotation of the Plane of Polarisation in Gases.—A. Kundt and W. C. Rœntgen.—Not susceptible of useful abridgment.

No. 16, December 18, 1879.

The Active Matter of Malt, or Maltin and Diastase. —M. Dubrunfaut.—Diastase is in reality merely an altered product, which accidentally retains about 1 per cent of maltin. The latter substance is the true active principle of malt.

Acceleration of Tanning by Means of Phosphoric Acid.—E. Ador.—Phosphoric acid, by hindering the tanning of the albuminoid substances, enables the tannin to traverse the skins more rapidly.

No. 17, December 25, 1879.

The "Egasse" Disinfectant.—This disinfectant is said to fix instantly all the gaseous or liquid bodies which in a mass of putrescent organic matter are the sources of all infections. In addition, it can be used as a remedy for the stings of insects, for the destruction of the phylloxera and other vermin, for the preservation of timber, &c. As a disinfectant its power is asserted to be 16 times greater than that of phenol, 14 times greater than that of cresylic acid, &c. No light whatever is thrown upon its nature and composition. It must be noted that in the account of this disinfectant, carbonic acid is classed among the "deleterious miasms" escaping from cess-pools.

Reimann's Färber Zeitung,
No. 46, 1879.

This issue contains nothing of general interest.

MEETINGS FOR THE WEEK.

MONDAY, 12th.—London Institution, 5.
—— Royal Geographical, 8.30.
—— Medical, 8.30.
TUESDAY, 13th.—Royal Institution, 3. Prof. Schäfer, "Physiology of Muscle."
—— Civil Engineers, 8.
—— Photographic, 8
—— Anthropological Institute, 8.
WEDNESDAY, 14th.—Society of Arts, 8. T. Bolas, F.C.S., "Modern Autographic Printing Processes."
—— Microscopical, 8.
—— Society of Public Analysts, 8. "On the Analysis of two Samples of Butter Several Hundred Years Old," by G. W. Wigner, F.C.S., and Prof. Church. "On the Composition of Unfermented Wines of Commerce," by J. Carter Bell, F.C.S. "On the Estimation of Fat in Milk," by W. M. Hamlet, F.C.S.
THURSDAY, 15th.—Royal, 8.30.
—— Chemical, 8.
—— Royal Institution, 3. H. H. Statham, "Modern Architecture since the Renaissance."
—— Royal Society Club, 6.30.
FRIDAY, 16th.—Royal Institution, 8. Prof. Dewar, "Investigations at High Temperatures," 9.
SATURDAY, 17th.—Royal Institution, 3. Prof. T. Rupert Jones, "Coal."

BURNDEN CHEMICAL WORKS, AND OTHER PREMISES, AT BOLTON, LANCASHIRE.

VALUABLE LEASEHOLD LAND, BUILDINGS, WORKING PLANT, MACHINERY AND APPARATUS FOR MANUFACTURING SODA ASH, SULPHURIC ACID, MURIATIC ACID, BLEACHING LIQUOR, SULPHATE OF COPPER AND BRONZE ASH; ALSO VALUABLE DYE WORKS, AND FOURTEEN MESSUAGES OR DWELLING-HOUSES.

LOMAX, SONS, & MILLS, will SELL by PUBLIC ACUTION (by order of the Mortgagees), at the THATCHED HOUSE HOTEL, New Market Place, in the City of Manchester, on Tuesday, the 20th day of January, 1880, at Two for Three o'clock in the afternoon (unless previously disposed of by private contract), subject to such conditions as will be then and there produced,—

ALL THOSE VERY VALUABLE AND EXTENSIVE CHEMICAL WORKS, situate in Burnden Street, Manchester Road, Bolton, in close proximity to the Lancashire and Yorkshire Railway, known as the

BURNDEN CHEMICAL WORKS,

consisting of Ore-breaking Shed, Pyrites and Sulphur Burning Houses, Sulphate of Copper Sheds, Salt Cake Shed and Store, Bronze Ash House, Chemical Shed, Rectifying and Cooling Houses, Loading Shed, Ash Sheds, Cooper's Shop, Ash Packing Place, Joiners' and Mechanics' Shops, Engine and Boiler-houses, Wheelwright's Shop, Smithy, Nitre Store, Stabling for 17 Horses, Provender Place, Hay and Straw Stores, Private and General Offices, Laboratory, Machine-house, Chimneys, and other erections; together with the Steam-boilers, Steam-engines, Millwright's Work, Steam, Gas, and Water Piping belonging thereto: and also the whole of the Working Plant, Machinery, and Apparatus set up, affixed, and belonging to the several departments of the said works and premises, and capable of manufacturing monthly upwards of 1000 tons of Soda Ash, Sulphuric Acid, Muriatic Acid, Bleaching Liquor, Sulphate of Copper, and Bronze Ash. The Working Plant consists of Black Ash Furnace, four Cast Iron Lixiviating Vats, Steam Jets, Liquor Wells, Liquor Settler, Evaporating Pan, Salting Down Pan, Soda Ash Finishing Oven, pair of Ash Crushers, and Rotating Sieve; 14 Pyrites Burners, two Nitre Ovens, Lead Concentrating Tower, three Vitriol Chambers and three Nitre Recovery Towers, Air Engine by Daglish and Co.; four Acid Eggs, four Liquor Cisterns, Boiling-down Pan, eleven Sulphur Burners, Vitriol Wash Tower, five Vitriol Chambers, and two cisterns, three Boiling-down Pans, Sixty Rectifying Furnaces, Salt-cake Pot and Roaster, eight Stone Acid Cisterns, and two Stone Condensing Towers, seven Stone Chlorine Stills, five Stone Bleaching Vessels, with Gearing and Agitators, Liquor Well, Stone Acid Cisterns, Lead and Iron Chemical Tanks, Feed Pump, Ore Grinding Mill, Riddling Machine, Copper Calcining Furnace, Wagon Hoist, Tramways and Turntable, Wash Tower, six Extracting Vats, Liquor Settler, two Precipitating Tanks, Copper Vat, Precipitate Roasting Furnace, three Evaporating Pans, thirteen Lead Crystallising Pans, Liquor Well, Steam Pump, Drying and Sampling Benches, two Boiling-down Pots and Furnaces, Drying Furnace, Boiling-down Pan and Furnace, Drainer and Well, Mortar Mill, Chaff-cutting Machine, Ten-ton Wagon Weighing Machine, and Office Fixtures; together also with the THREE PLOTS of LAND, forming the site thereof, and occupied therewith, and containing altogether 24,318 square yards, or thereabouts.

The Premises are Leasehold, and are held for the residue of three several terms of 990 years, 999 years, and 990 years, subject to three several ground rents amounting in the aggregate to £120.

The Buildings, which are brick-built and slated (the sheds being erected on brick pillars), are excellently adapted for the purposes of the business, a large sum of money having been expended in their construction (a considerable portion of such sum within the last few years), and are most eligibly situated, the Lancashire and Yorkshire Railway being immediately contiguous to the Works. Gas and Water Mains are laid throughout, and there is a never-failing supply of water for all purposes. Immediate possession can be had.

Also those valuable PREMISES, situate in Burnden-fold aforesaid (adjoining the last-described premises), formerly used as a DYE WORKS, with the STEAM BOILER, STEAM ENGINE, SHAFTING, GEARING, PIPING, and FIXTURES thereto belonging, which, with the ELEVEN COTTAGES adjoining, being Nos. 3, 5, and 7, Haslam-street, 11, 13, 15, and 17, and 9, 25, 27, and 29, Burnden-fold aforesaid, and the site whereof contains 1302 square yards, are held for residue of term 999 years, at yearly rent of £7 14s. 1½d., and are subject to a lease for five years, at the yearly rent of £70, and will be sold subject to such lease.

Also all those TWO MESSUAGES, or DWELLING-HOUSES, and CELLAR, with the YARD, OUTBUILDINGS, and APPURTENANCES thereto belonging, situate and being Nos. 209, 211, and 213, Manchester-road, and 6 and 8 at the back, and known as Back Burnden.

Site, 248¼ square yards. Term, 999 years. Apportioned yearly rent, £2 2s. 10d.

The whole of the foregoing properties will, in the first instance, be offered for sale in One Lot, and if not so disposed of will then be offered in Two Lots, viz.:—

LOT 1. Land, Chemical Works, Dye Works, and Dwelling-houses.

LOT 2. The whole of the Plant and Machinery.

The Conditions of Sale will be open for inspection at the Offices of Messrs. HOLDEN and HOLDEN, Solicitors, Bolton, seven days before the day of sale.

Full particulars of which will be given on application to Messrs. P. and J. KEVAN, Accountants, 12, Acresfield, Bolton; the AUCTIONEERS, 15, Wood-street, Bolton; Messrs. RICHARDSON and MARSHALL, Solicitors, 18, Wood-street, Bolton; or to

Messrs. HOLDEN and HOLDEN.
Solicitors,
Bolton.

The Prestolee Alkali Works, Farnworth, near Bolton, Lancashire fitted with costly plant, machinery, and apparatus for the manufacture of soda-ash, bleaching-powder and liquor, and sulphuric acid, in complete working order. With possession.

MESSRS. FULLER, HORSEY, SONS, and CO., are instructed to SELL by AUCTION, at the Palatine Hotel, Manchester, on Friday, January 16th, at 3 precisely, in one lot (unless an acceptable offer be previously made by private contract), the PRESTOLEE ALKALI WORKS, a freehold property, having a superficial area of 95,741 square yards of land, subject to chief rents amounting to £407 13s. 9d. per annum, with the buildings, plant, machinery, and apparatus erected thereon, capable of manufacturing monthly a product exceeding in the aggregate 2000 tons of soda-ash, bleaching-powder and liquor (by Weldon's patent process), and sulphuric acid, also caustic soda and muriatic acid. The amount expended in the construction of these works has been very large. A valuation was made with great care in 1874 by Messrs. Holmes and Son, the well-known valuers, of Manchester; their estimate then amounted to £99,900, and since that time a sum exceeding £10,000 has been expended. The whole of the works and plant have been well kept, and are conveniently arranged for working. The Bury, Bolton, and Manchester Canal, which forms one boundary of the property, affords facility for economical water carriage, and the Lancashire and Yorkshire Railway is within a very short distance. There is a plentiful supply of water for all manufacturing purposes, free of cost, from the river Croal, and coals are raised from pits in the immediate neighbourhood. Pyrites, salt, lime, and limestone are all brought by boats direct to the wharf on the canal. The works may be economically worked with a small capital, as arrangements may be made with the vendors for a very considerable portion of the purchase-money to remain upon mortgage. Large profits have been realised in the past, and the high reputation of the Prestolee manufactures in the market will ensure to an energetic man, even at the existing low prices, an ample return for his capital invested, and possession of works not surpassed for completeness or compactness by any in the kingdom. May be viewed till the sale. Printed particulars may be had at the works; at the Palatine and Queen's Hotels, Manchester; of Messrs. Wakeman and Bleeck, Solicitors, Warminster; of Messrs. Christopher and Son, Solicitors, 28, Argyll Street, Regent Street, W.; and of Messrs. Fuller, Horsey, Sons, and Co., 11, Billiter Square, London, who are empowered to treat for the disposal by private contract, or an offer for renting would be entertained.

POLYTECHNIC.—MARY QUEEN OF SCOTS.—The principal events in the life of the beautiful and unfortunate Mary Stuart, illustrated by Tableaux Vivants. The descriptive poem recited by Miss Alice Burnelle. The appropriate vocal music by a Choir of Glee Singers, under the direction of Mr. Stedman, daily at 3.30 and 8.30; Edison's Loud Speaking Telephone, &c., by Mr. Daniel, 10.30; the Zulu War and the Heliograph, by Mr. King, 11; London as it Was and Is, 11.30 and 8; the Electric Light, 12; Instrumental Concert by the Paggi Family, 2.30 and 7.30; Popular Optical Lecture, 3, by Mr. King: Phenomena of Light and the Ghost; by Mr. King, 6.30. Open 10 till 1, 2 till 5, and 6 till 10. Admission 1s. Reserved Seats, 2s., 1s., and 6d.

THE JOURNAL OF SCIENCE

AND ANNALS OF

ASTRONOMY, BIOLOGY, GEOLOGY, INDUSTRIAL ARTS, MANUFACTURES, AND TECHNOLOGY.

This Journal is a medium of communication between the Scientific Investigator and the Reading Public, and also between Students in the various branches of science.

Price One Shilling and Sixpence.

Now ready, No. LXXIII., *January*, 1880.

CONTENTS.

The History of Evolutionism.
Scientific Progress of the Past Year. An Address delivered before the Royal Society by Wm. Spottiswoode, D.C.L., LL.D., P.R.S.
The Hon. Henry Cavendish; his Life and Character.
English and American Physique. By George M. Beard, M.D.
On Water and Air. By Prof. Tyndall, D.C.L., LL.D., F.R.S.
The Thomas and Gilchrist Process for Eliminating Phosphorus in the Manufacture of Steel. By W. Mattieu Williams, F.R.A.S
Professor Barff's Process for Preventing the Corrosion of Iron.
Analyses of Books, &c., &c.

London: 3, Horse-Shoe Court, Ludgate Hill.

THE CHEMICAL NEWS.

Vol. XLI. No. 1051.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 2.)

III. Use of the Periodic Law for the Determination of the Atomic Weights of the Little Known Elements.

When an element has very little power of combining with oxygen, and when only a small number of its other compounds are known, it is necessary, for finding the atomic weight of this element, to learn its equivalent (relatively to hydrogen), to determine the physical properties of the body in a simple state (such as its capacity for heat), or those of its compounds (such as vapour density and capacity for heat), or to find a case of isomerism. As some of these determinations have many practical difficulties, and because in a great number of cases the methods of working are defective, the atomic weights of many elements have been determined according to very uncertain data. Therefore, because we are not certain of a sufficient number of properties, we often give the formula RO to strongly basic bodies (this is the reason why the oxides of Ce, Yt, Di, and La, particularly, have been given this formula), the formula R_2O_3 to weak bases (as oxide of uranium), and RO_2, R_2O_5, and RO_3 to acid oxides. This method has been admitted as incorrect, since the formula of oxide of beryllium has been found to be BeO, with feeble basic properties, and the formulæ of the highly basic oxides of Th and Zr to be RO_2.

Lastly, it will be sufficient to remember that the highest compounds of oxygen, such as OsO_4 and RuO_4, have, only weak acid properties.

It is absolutely certain that the basic and acid properties of oxides are determined not only by the number of atoms of oxygen contained therein, but also by the properties of the element. The proof of it has been given in the preceding developments of the nature of the periodic law. The element which comes after Th (twelfth series) and whose atomic weight is about 235, ought to have basic properties, even under the form of oxide, R_2O_5. It is for the same reason that many of the formulæ of oxides, above all the oxides of the rare elements, which have not yet been thoroughly studied, such as, In, Ur, Ce, La, Di, Yt, and Er, are not not legitimate. Hardly any clear cases of isomerism have been observed in the oxides, and some of the isolated facts of this kind, such as the isomorphism of oxide of zirconium, and oxide of beryllium with alumina, cannot lead us to any certain conclusions.

In general, it is necessary to observe that isomorphism gives only a feeble support to conclusions on the atomic composition of bodies; the case of isomorphism presented by bodies of different composition, and the phenomena observed by Marignac, which have been already mentioned, are already sufficient proof. Without pushing any further into this vast and obscure region, I will simply remark that even the capacity for heat, as much in simple as in compound bodies, does not always give us very clear results. Thus we have left only two kinds of permanent criteria for finding the atomic weights; the determination of the vapour density of a large number of compounds of the given element, and a means of controlling, of a purely chemical nature, or conclusions drawn from the composition of the different forms of oxides and from the discovery of analogies with sufficiently well-known elements, &c. The capacity for heat and isomorphism can only be looked upon as auxiliary means. These methods are almost completely wanting for the above-mentioned rare elements; because, except a few exceptions, they only give volatile compounds, which have been too little studied to authorise any conclusions on the analogies.

The periodic law comes to our aid in cases of this kind, by offering us a new regular relation between the chemical properties and the atomic weights. This law being admitted, we can determine the atomic weight of an element of which the equivalent and some properties are known. If we multiply the equivalent E of an element deduced from the highest oxide (its composition being E_2O, and that of the chloride ECl) by 1, 2, 3, 4, 5, 6, 7, we obtain the values of all possible atomic weights of this element, and one of these numbers expresses the true atomic weights; this number E_n corresponds to a place as yet unoccupied in the system, and at the same time to the atomanalogy of the element. For, to judge of it according to what we know at present, a particular place in the system can only receive one element, and the atomic analogies are of a very simple nature.

Let us suppose that an element gives a basic oxide, not very energetic, and whose equivalent is 38. (It must not be forgotten that this number has a slight inevitable error.) We want to know the atomic weight of the element or the formula of its oxide. If we adopt the formula R_2O for the oxide, R=38 and the element belongs to the first group; but the place is already occupied by K=39; and, further, the atomic analogy indicates a soluble and energetic base for this place. If we adopt for the oxide of the formula RO the atomic weight=76, the atomic weight will not allow it to be in the second group, because Zn=65, and Sr=87, all the places for elements of low atomic weights are filled in this group. If we adopt for the oxide the formula R_2O_3, then the atomic weight, R=144, and the element goes into the third group, where there is in fact between Cd=112 and Sn=118 a place for an element whose atomic weight is near 114. The oxide of the given element should, according to its atomanalogy with Al_2O_3 and Tl_2O_3, as well as with CdO and SnO_2, possess feebly basic properties. Therefore, this element should be placed in the third group. If we adopt for the oxide the formula RO2, the atomic weight=152, the element in question should not be placed in the fourth group, because only an element having an atomic weight 162, and feebly acid properties, could adapt itself to the empty place in this group (to form the link between PbO_2 and SnO_2). There is still in the eighth group a place for an element whose atomic weight would be 152; but this element forming the transition from Pd to Pt, should have such properties like them, which could not remain hidden. If then the given element does not possess these properties, the above-mentioned atomic weight does not do for it, any more than the place in the eighth group. If we adopt for the oxide the formula R_2O_5, then R=190, which will not do for the fifth group, because Ta=182 and Bi=208. Further, Ta and Bi possess, in the form of R_2O_5, acid properties.

The forms of oxides RO_3 and R_2O_7 do not correspond any better with our element. The only atomic weight which does for it is, therefore, 114, and the formula of its oxide is R_2O_3. Such an element is *Indium*. Its equivalent, according to Winkler, is 37·8; therefore we ought to accept the number 113 for its atomic weight, and the formula In_2O_3 for the composition of its oxide. Up to the present we have made R=75, and we have adopted InO for the formula of its oxide. Al and Tl are indium atomanalogues of the third group, Cd and Sn atomanalogues of the seventh series.

Let us compare the apparent properties of indium, deduced from atomanalogues, with the properties really observed.

The atomanalogues of indium, Cd, and Sn being easily reducible (they can even be reduced from their solutions by zinc), indium should also be reducible. As Ag (seventh

series, first group) is more difficultly fusible than Cd, and Sb more difficultly fusible than Sn, it is necessary, according to the atomanalogy of Ag, Cd, In, Sn, that indium should be more easily fusible than cadmium. In fact, indium melts at 176°. Ag, Cd, and Sn are of a greyish-white colour, and so is indium. The density of Cd is lower than the density of Ag, the density of Sb is lower than that of Sn, the density of indium should then be a little lower than the average between Cd and Sn. In reality it is so. The density of Cd = 8·6, that of Sn = 7·2; therefore the density of In ought to be less than 7·9. it has been found to be 7·42. As Cd and Sn oxidise at red heat, and do not rust in the air, these properties should also be found in In, but more feebly than in Cd and Sn, because Ag and Sb oxidise still more difficultly.

All that has just been said has been verified by experience. We arrive at the same conclusions in comparing In with Al and Tl; thus the density of Al = 2·67, that of Tl = 11·8, the average density would be 7·2.

We now pass to the properties of the oxide, and to the reactions of the salts. Indium and its atomanalogues are found in the odd series; this is why the higher oxides cannot be strongly basic; the basic character should be more feeble in In_2O_3 than in CdO and Tl_2O_3; it should also be stronger than in Al_2O_3 and SnO_2. These conclusions are confirmed by the following facts: The oxides of Al and Sn dissolve in alkalies, forming definite compounds, while the oxides of Cd and Tl are insoluble in alkalies; In_2O_3 is soluble in alkalies, but without forming any definite compound. The oxides of Cd, Sn, Al, and Tl are difficultly fusible powders, like In_2O_3. Hydrate of In_2O_3 forms, as could be foreseen, a colourless gelatinous mass. The oxides Al_2O_3 and SnO_2 are easily precipitated from saline solutions by carbonate of barium; it is the same with In_2O_3. Sulphuretted hydrogen precipitates Cd and Sn from their acid solutions; In is also precipitated. All these reactions have been confirmed experimentally.

Here are a few more facts deduced from atomic analogies, although they have not been observed, or have not been sufficiently studied: Indium ought to furnish indium-ethyl $InAe_3$, prepared in the ordinary way, because $CdAe_2$ and $SnAe_4$* exist; this compound, according to the atomic analogies, ought to boil at about 150°. As two elements, Sn and Tl, atomically analogues to indium, each give (independently of the higher oxide) a lower more basic oxide, indium would apparently also give a suboxide, InO or In_2O, turning in the air into In_2O_3. Apparently chloride of indium, $InCl_3$ or In_2Cl_6, cannot evolve chlorine when heated, because SnO_4 does not possess that property. The sulphate of cadmium forming with sulphate of potassium a double salt of the form $K_2Cd(SO_4)_2$, and aluminium giving an alum $KAl(SO_4)_2$, indium would no doubt give an analogous double salt; in any case, it is impossible to foresee if this salt will be isomorphous with alum.† To control the exactness of the modifications to be introduced into the atomic weight of indium, and into the formula of its oxide, conformably to the developments given above, I determined the specific heat of this body, and I found it to be 0·055, which is in accord with the periodic law.‡ A little time before Bunsen employed his new and elegant calorimetric process for determining the specific heat of indium. The two numbers agree. Bunsen found 0·057. We can then, without the slightest doubt, apply the periodic law for correcting the atomic weights of elements which are little known. Because of this certainty I will offer some considerations relative to other elements. I will only remark now that the periodic law has assigned a determinate position to all the elements more or less known, at the present time, and that this fact, far from being of small value, corroborates the law emphatically. Before leaving indium I would notice this: In is an analogue of Zn and Cd up to a certain point; it accommanies them in nature, and it is near them in the system; it is nearly the same which takes place for Nb relatively to Ti and Zr.

* Cadmium-ethyl has not been studied much; still, for many reasons, it merits research. Atomically analogous to Zn and Hg it should boil at 130°. The study of indium-ethyl and of thallium-ethyl would throw a new light on aluminium-ethyl, unhappily little known.

† Only having a small quantity of indium, I have, up to the present, only been able to make one incomplete experiment; an acid solution of sulphate of indium, with an equal quantity of K_2SO_4, left under sulphuric acid, after the addition of alcohol, give crystals formed of microscopic cubes. I recognised it, not only by its form, but also by the absence of double refraction of light.

‡ *Bulletin de l'Académie des Sciences de Saint Petersbourg*, 1870, p. 445.

ON THE SEPARATION AND ESTIMATION OF CADMIUM IN THE PRESENCE OF ZINC; WITH REMARKS UPON THE SEPARATION OF COPPER, CADMIUM, AND ZINC.

By CHRISTOPHER CLARKE HUTCHINSON, Assoc. R.C.Sc.

A SHORT time ago I conducted an investigation on the influence of *mass* in chemical reactions, particularly directing my attention to the influence which copper, cadmium, and zinc exercise upon each other, and their mutual relations during precipitation. The two latter metals seem to have many points in common with each other, and show great similarity in their behaviour towards most chemical reagents.

The investigation necessitated an examination of the methods in use for the separation and estimation of these metals. Most of such processes proved very unsatisfactory; I was therefore obliged to make some experiments in order to determine the methods most reliable. In this paper I shall give the results I obtained, and the methods found most accurate. Standard solutions of the pure crystallised sulphates made from the pure metals were used throughout.

Separation of Cadmiun and Zinc.—If an acid solution containing both of these metals be treated with sulphuretted hydrogen, the cadmium should be precipitated as the sulphide, while the zinc should remain in solution. The reaction, however, is not so complete as indicated; and its behaviour is dependent upon the amount of acid present in *excess*. If too great an amount of acid be present, the cadmium will only be imperfectly precipitated; while, on the other hand, if the solution be not sufficiently acid, a portion of the zinc undergoes precipitation as sulphide with the cadmium. A method of separation based upon this behaviour will only yield satisfactory results when the relative quantity of each metal present is approximately known, so that the quantity of acid can be adjusted (whether the one or the other be present in a larger quantity), so as not to prevent the total precipitation of cadmium or favour that of zinc. Even when very carefully conducted, it is often found necessary to re-dissolve the sulphides obtained, and to re-precipitate, so as to thoroughly eliminate every trace of zinc.

The method of separation described by Fresenius, and usually given by other authorities, is also open to the objection of not yielding concordant results, even though every precaution be observed in the process and the quantity of the reagents be carefully adjusted. This method is based upon the insolubility of the hydrated oxide of cadmium in an alkaline solution containing tartaric acid. To the hydrochloric acid solution of the two, as near as possible neutral, tartaric acid is added; sufficient sodium or potassium hydrate is then added until the solution is distinctly of an alkaline reaction. If this solution be boiled for about two hours, the hydrated oxide of cadmium separates out on cooling, the zinc being left in solution. After filtration, the hydrated oxide is ignited and weighed as the oxide (CdO). The zinc may be precipitated as the sulphide by ammonium sulphide, or titrated with sodium sulphide.

Two examples may be given, showing the mutual variability in estimations which should each have yielded the same result. In each case the determination of the amount of cadmium contained in a mixed precipitate of zinc and cadmium was the object in view.

	Grm.			Grm.
No. 1 gave CdO ..	0·0805	or	Cd ..	0·0704
„ 2 „ CdO ..	0·0615	„	Cd ..	0·0538
Differences ..	0·0190			0·0166

The next example given shows the result of experiments upon precipitates of the same nature, but containing a larger amount of each substance.

	Grm.			Grm.
No. 3 gave CdO ..	0·194	or	Cd ..	0·1697
„ 4 „ CdO ..	0·1165	„	Cd ..	0·1019
Differences ..	0·0775			0·0678

The differences here shown, taken in relation with the comparatively small amount of the metal present, are serious, and indicate the method as unreliable. The subsequent zinc-estimation in all of these cases showed that in *no instance* was the whole of the cadmium present precipitated; the error, therefore, relatively to the *total* cadmium present, was even larger than above shown. This was amply confirmed by other experiments, in all of which the solubility of the hydrated oxide of cadmium, and its subsequent precipitation with the zinc as sulphide, was inevitably found; in many instances the quantity was so great as to impart quite a deep yellow colour to the otherwise white zinc sulphide.

Experiments were now made in which advantage was taken of the difference of behaviour of the two sulphides when boiled with a solution of potassium cyanide, sulphide of zinc being very *soluble* and the sulphide of cadmium *insoluble* in that reagent. This method appears, at first sight, to be both convenient and accurate. Several trials, however, showed that it was unsatisfactory; the difficulty of obtaining pure potassium cyanide free from iron, the subsequent destruction of the cyanide, and the large excess of potash salts left, with their effect upon the estimation of the zinc, gave results far from approaching the accuracy desirable.

After several trial experiments, the following method was adopted. It is based upon the difference of action of ammonium carbonate upon the precipitated metallic carbonates, and yields accurate and concordant results. From considerable experience it can be recommended by the author for the separation and individual estimation of the two metals.

The hydrochloric solution containing the two is evaporated to dryness on the water-bath, preferably in a platinum dish, so as to expel the excess of acid. The dried chlorides are then re-dissolved in about three times the amount of distilled water necessary for their complete solution; the aqueous solution is heated upon the water-bath almost to boiling, and a concentrated solution of pure sodium carbonate is added until there is a distinct alkaline reaction. At this temperature a granular precipitation of the carbonates of both metals occurs, which very quickly settles down and allows filtration almost immediately. After standing a short time the carbonates are thrown upon a filter and thoroughly washed, the nature of the precipitate rendering this very easy of execution. The washed carbonates are then re-transferred to the platinum dish with just a sufficient quantity of wash-water to completely remove them from the filter. If this be carefully done, it is by no means difficult to effectually remove the whole of the precipitate without loss from adherent portions. A saturated solution of pure ammonium sesquicarbonate is then added in considerable excess; after stirring, the mixture is allowed to stand in a warm chamber for about six hours. The whole of the zinc carbonate passes into solution; the cadmium carbonate, being insoluble, rapidly settles down. It is then thrown upon the same filter as before used, and washed: the filtrate and washings contain the zinc. After drying, it is ignited in a porcelain crucible and weighed as the oxide (CdO). Care must be taken to avoid the presence of any small particles of filter-paper during ignition; otherwise reduction of the oxide will occur, and loss by volatilisation as the well-known brown cadmium vapour. The filter-paper is saturated with ammonium nitrate to prevent volatilisation of the small amount of adherent particles; it is then ignited in the usual way, either upon the lid of the crucible and not in contact with the oxide, or, more conveniently, in a smaller crucible: carefully conducted, little or no loss by reduction occurs. The filtrate containing the zinc is evaporated down to a small bulk to drive off the excess of ammonium salts, diluted to a convenient extent, and titrated with a standard solution of sodium sulphide in the usual manner.

The following examples may be given to show the success of this method. 10 c.c. of solution of each of the pure sulphates containing known amounts were mixed, excess of ammonia added, and their complete precipitation effected by addition of ammonium sulphide in excess. The washed sulphides were then dissolved in hydrochloric acid, and the solution treated as above described. The following are the results obtained in each instance:—

No. I.

	Grm.
Cadmium actually present	0·112
„ „ found	0·117
Error	0·005+
Zinc actually present	0·065
„ „ found	0·065

No. II.

Cadmium actually present ..	0·1163
„ „ found	0·1239
Error	0·0076+
Zinc actually present	0·065
„ „ found	0·065

To ensure rigorous comparison in each of the above cases, the amount of each metal present in the 10 c.c. of solution taken was directly determined by taking at the same time a corresponding separate quantity of each of the solutions: the zinc solution was titrated with sodium sulphide, and the cadmium precipitated as the carbonate, ignited, and weighed as the oxide.

Other examples could be given, in which the error in the cadmium estimation did not exceed 0·5 of a milligrm. in 0·112 grm. total amount present; the zinc estimations were equally as favourable as the two examples quoted. In an extended series of separations of unknown quantities of the two sulphides the results were exceedingly concordant with each other, the relative quantity of each present being exceedingly variable.

Separation of Copper, Cadmium, and Zinc.—The methods of separation of copper from either cadmium or zinc, or both of these metals, were in most instances carefully examined. That which presents the most favourable features is by means of potassium sulphocyanide, being alike convenient and accurate.

The remarks upon the separation of zinc from cadmium by sulphuretted hydrogen in an acid solution apply in a similar manner to the present case, its separation from copper. Most processes which effect the separation of copper and zinc can be also applied in the case of copper and cadmium. Special attention was given to the two following methods of separation:—(1) That based upon the extremely sparing solubility of the sulphide of copper in a dilute solution of sulphuric acid (1 of H_2SO_4 + 5 of H_2O), and the complete solubility of the other two sulphides. (2) That founded upon the precipitation of the copper, in presence of the other two metals, as cuprous

sulphide by the reagent sodium thiosulphate ($Na_2S_2O_3$). Neither of these was found convenient, or the separation by any means so complete as is desirable, especially when small quantities are required to be operated upon.

The sulphocyanide process was conveniently conducted as follows:—The nitric acid solution containing the three metals, or any one of the remaining two with copper, was evaporated to dryness to expel the excess of acid. A sufficient quantity of sulphurous acid was then added to effect re-solution with an equal bulk of distilled water. The potassium sulphocyanide was then added in the smallest possible excess: this is accompanied with the formation and precipitation of the pink-white cuprous sulphocyanide, $Cu_2(CyS)_2$. After allowing to settle, the precipitate was thrown upon a filter and thoroughly washed. It was then re-transferred to an evaporating basin, dissolved in a small quantity of nitric acid, evaporated to dryness, re-dissolved in water, excess of ammonia added, and finally titrated with a standard solution of potassium cyanide in the usual manner. The filtrate and washings containing the cadmium or zinc, or both, was evaporated to a small bulk on the water-bath, and at this temperature precipitated by pure sodium carbonate. Their separation was then proceeded with as before described. If cadmium be present, its precipitate is washed, dried, ignited, and weighed as the oxide. If zinc only be present it can be similarly treated, or re-dissolved in hydrochloric acid and titrated by sodium sulphide. Considerable experience proved this method to be the most expeditious, convenient, and accurate of those usually employed for the separation of these metals.

The experiments were made in Prof. Galloway's laboratory at the Royal College of Science.—*Philosophical Magazine*, December, 1879.

ON THE

DETECTION OF ORGANIC MATTER IN WATER.

By F. TIEMANN and C. PREUSSE.

The authors premise the statement that according to previ iling opinion putrescent organic matter is the most suitable medium for the development of disease ferments which may be distributed by air and water as well as by animals. Whilst the foreign mineral matter in water is easy to detect and to determine, the recognition of organic impurities, and still more their quantitative estimation, is attended with the greatest difficulties. Among these the bodies formed by fermentation from the albuminoids, the fats, and the carbohydrates deserve particular attention. Among the products of the albuminoids the following have been recognised:—Peptons, amido-derivatives of mono- and bibasic acids of the fatty series (leucin, asparagic acid, glutamic acid, &c.), acids of the fatty series (valerianic, butyric, &c.), trimethylamin, and the following compounds belonging to the aromatic series:—Phenol, cresol, indol, scatol, tyrosin, hydro-para-cumaric acid, &c. The fats are split up into glycerin and fatty acids rich in carbon, which are afterwards or simultaneously transformed by oxidation into acids of lower groups. From the carbohydrates there are formed by fermentation a number of alcohols (aldehyds) and acids of the fatty series. Waters in connection with cesspools may further contain the constituents of urine and their products of decomposition. Where the residues of vegetation are decaying, substances of the humus class, poor in nitrogen, will also be present. Hence the organic impurities of water may differ almost infinitely in their properties. Fixed and volatile bodies, permanent and unstable compounds, may occur together. Hence there cannot exist any simple method for determining the total amount of the organic matters in water. The following methods have been hitherto employed:—

I. *Determination of Organic Matter by the Ignition of the Residue left on Evaporation at a Fixed Temperature.*

The residues obtained after evaporation at 80° have been ignited with access of air, and the caustic lime thus produced re-converted into carbonate by means of ammonic carbonate, the final loss of weight being taken as organic matter.

The authors remark that fixed organic substances may be partially decomposed during evaporation; that the mineral substances present may at 180° retain variable proportions of water; that silicic acid may expel carbonic acid which is not restored by treatment with ammonic carbonate; and that small quantities of organic chlorides may be volatilised, whilst the organic matter may react upon nitrates and nitrites. Hence the result stands in no direct proportion to the fixed organic matter originally present in the water.

II. *Method of Frankland and Armstrong.*

For the description of this process and of the apparatus the reader is referred to Sutton's "Volumetric Analysis" (Second Edition, p. 259).

In this method its authors do not take into account the organic substances present in water and volatile in acid solutions. Nor do they regard the decompositions which the fixed organic compounds may undergo during the evaporation of the water under the influence of sulphurous acid and of the ferrous chloride generated. As the percentage of carbon and nitrogen in various organic compounds varies, the numbers found give no clue to the absolute quantity of fixed organic matter present in the water examined, and the results of a comparative examination of different waters by this method will be comparable only when the mixture of organic matter present in each case is alike in its nature. The method shows, however, whether nitrogenous matter, not volatile from acid solutions, is present.

III. *Method of Dittmar and Robinson.*

For a full description of the process the reader is referred to the Chemical News (vol. xxxvi., p. 26).

The authors consider that it can be executed more rapidly and with somewhat simpler appliances, but that it is open to the same objections. It is an approximation to the methods of F. Schulze and F. Bellamy.*

IV. *Determination of Organic Matter by Means of Permanganate.*

The authors describe the modifications proposed by Kubel, Schulze, and Tidy. The first of these, which they consider preferable, consists in acidulating with dilute sulphuric acid, and boiling for ten minutes with an excess of centinormal permanganate. The residue of the latter is decomposed by a centinormal solution of oxalic acid, and the excess of the latter titrated with permanganate. From the total quantity of the latter the proportion which has served for the oxidation of the oxalic acid is deducted, the remainder showing the permanganate decomposed by the organic matter of the water.

These methods take into account the volatile organic matter as well as that of a fixed nature. The different organic compounds, however, contain very different proportions of carbon, hydrogen, and nitrogen, and therefore consume very various quantities of oxygen. The authors consider that Tidy's process is "provided with a series of sources of error."

V. *Fleck's Method.*

In place of permanganate the authors used a solution of silver nitrate in hyposulphite of soda mixed with caustic soda. The standard solutions required in this process are very liable to change, and the final reaction is easily overstepped as in all "spotting" processes.

Further, the silver solution is directly inferior to permanganate as a reagent for organic matter.

* *Zeit. Anal. Chem.*, viii., 494 and 495.

In connection with the examination of the permanganate processes, the authors have found by direct experiment that volatile organic substances are to be found in waters, and they even recommend that special attention be paid to contaminations of this nature. Kubel's process, they admit, gives no especial clue to the presence or absence of nitrogenous matter, a problem which, to a certain degree, they regard as solved by the remaining process.

VI. *Method of Wanklyn, Chapman, and Smith.*

The authors describe briefly this method, omitting the addition of carbonate of soda for the first distillation, and remark that the process is simple and easy, and gives when the instructions of its inventors are closely adhered to, comparable results. Small portions of volatile organic matter may, they consider, escape prior to the addition of the alkaline permanganate. It is also not very easy to obtain this solution free from ammonia. The transformation of organic nitrogen into ammonia is most complete in the decomposition-products of the albuminoids. Just as was shown to be the case with the methods of Frankland and Kubel, this process shows the comparative quantities of nitrogenous matter in different waters only when similar mixtures of organic compounds are present.

In summing up, the authors consider it more probable that disease-ferments are present in a polluted than in a pure water, though it must not be inferred that every impure water must necessarily prove pernicious. When it becomes pernicious neither the physician nor the chemist can decide, though both may point out when it should be avoided as suspicious.—*Berichte der Deutschen Chemischen Gesellschaft.*

DETERMINATION OF CHROMIUM AND TUNGSTEN IN STEEL AND IN IRON ALLOYS.

By RUDOLF SCHÖFFEL.

The author first removes the greater part of the iron by treating the comminuted material with the double chloride of copper and sodium, or of copper and ammonium. The residue, which contains all the chrome combined with small quantities of iron in a porous state, is rendered soluble by fusion with saltpetre and sodic carbonate. The melted mass, which may be coloured green by manganese, is digested with water till the rest appears pulverulent, whereby any manganic acid is decomposed, and the liquid is filtered. A solution is thus obtained containing the chrome as an alkaline chromate. If no important proportion of silica is present, as in some kinds of cast-steel, the liquid may be cautiously neutralised with nitric acid, precipitated with mercurous nitrate, and the chromium determined in the well-known manner; but as notable quantities of silica may be present in the solution, especially in crude chrome irons, it must first be removed by the usual process. The solution of the melted mass is neutralised with hydrochloric acid, a small quantity of alcohol being added, and evaporated to dryness. After filtering off the silica the chrome is precipitated with ammonia and ammonium sulphide in the usual manner.

This method is universally applicable for chrome-steel, but for crude chromium and chrome-iron alloys it is available to a certain limit only. If such a compound contains more than about 8 per cent of chrome, then on treatment with the double salt of copper a part of the iron is, indeed, dissolved, but the less the higher is the percentage of chrome. The residue does not assume that porosity which is required for the treatment with nitre and soda.

In such cases the only expedient is to digest the comminuted material for a long time in hydrochloric acid with the aid of heat. It is an erroneous supposition that on treating such iron with hydrochloric acid the chromium is found in the residue. If the proportion of chrome is low it is entirely dissolved, even in dilute acid. In richer alloys a portion of the chrome remains undissolved. If the chrome exceeds about 30 per cent neither this metal nor the iron dissolves on prolonged digestion in hot acid. Such alloys are not attacked either by *aqua regia*, bromine, or cupric chloride.

The portion not dissolved in hydrochloric acid is fused in the usual manner with sodic carbonate and saltpetre, the melted mass is dissolved in water and hydrochloric acid, and the solution mixed with that already obtained by treating the iron with hydrochloric acid. The chrome is then determined in this solution by a process devised by E. Donath.

The solution is neutralised so far that it still remains distinctly acid, and mixed with sodic acetate, which should occasion no precipitate. Solution of permanganate is then added, and the whole heated to a boil, when the greater part of the iron is precipitated. The supernatant liquid after boiling should still appear distinctly red. A few drops of alcohol are then added till the colour disappears; sodic carbonate is then added to complete the precipitation of the iron, the liquid is again heated, and filtered. In the filtrate the chrome is found as alkaline chromate.

Or, instead of permanganate, the author adds to an acid solution in presence of sodic acetate bromine. If so much acetate is added that the liquid contains free acetic acid, but no hydrochloric acid, the oxidation takes place rapidly. The operation is best performed in a flask, which is closed after adding the bromine, and frequently shaken. After some hours the bromine is expelled by boiling, and the iron completely precipitated with sodic carbonate. This method is especially recommended where a simultaneous determination of manganese is required.

For the determination of tungsten in steels and tungstiferous iron the author employs the method given above for chrome. In the rare case of a notable proportion of silica the tungstic acid, after being weighed, is melted with potassic bisulphate, the melt treated with water, and the undissolved silica deducted from the gross weight of the tungstic acid, If the tungsten exceeds 12 per cent, which rarely occurs, this method is open to the same objections as in the case of chrome, except the material is very finely pulverised. The residue, after treatment with the double salt of copper, is washed, dried, and ignited in a crucible with exposure to air before fusion with nitre and carbonate of soda.—*Berichte der Deutschen Chemischen Gesellschaft.*

VOLUMETRIC DETERMINATION OF CERIUM.*

By Prof. FRANZ STOLBA.

Exactly like calcium oxalate, ceric oxalate can be volumetrically determined by means of potassic permanganate. Pure ceric sulphate, carefully dehydrated, was dissolved to the volume of a litre, and measured portions of the solution were precipitated with ammonium oxalate, the latter being determined in the known manner with standard permanganate, the solution of the latter being standardised by means of lead oxalate.

On the other hand, portions of the solution were taken for determination as cerium oxide. Using the atomic weight Ce = 141·27, as ascertained by Bührig, the quantity of cerous oxide was ascertained from the quantities of standard permanganate consumed.

The results were very concordant and satisfactory, and where differences appeared they fell within the inevitable errors of observation. Hence cerium, when freed from lanthanum and didymium, and separated as oxalate, may be conveniently and accurately determined as such. A corresponding quantity of sulphuric acid must be applied in titration and warm water used. During the process the

* Communicated by the Author.

quantity of undissolved matter decreases, and the change of colour at the conclusion is distinctly marked.

The author considers his results as confirmatory of Bührig's atomic weight, Ce = 141·27.

PROCEEDINGS OF SOCIETIES.

NEWCASTLE CHEMICAL SOCIETY.

General Meeting, December 18, 1879.

Mr. John Glover in the Chair.

The minutes of the last meeting were read and confirmed.

Mr. J. Petrie was elected a member of the Society.

The Chairman—I believe the next business is the question of the amalgamation of the two Societies which have existed for some time in this district. As to the desirability of this amalgamation I think there cannot be two opinions. As the members are aware, there was a joint meeting of the two Committees held (at which I am sorry I was unable to be present) to consider the question, and as the result of that meeting I believe Mr. Swan has a resolution to submit to the Society this evening.

Mr. Swan—I have to explain that the President is unavoidably absent; and, knowing that he could not be present, he wrote to me to ask me to submit to you a resolution on the subject of amalgamation. In accordance, then, with the unanimously expressed wish of the Committees of the two Societies, I beg to move the following resolution:—

"That this meeting cordially approves the project of amalgamation of the Newcastle Chemical Society with the Tyne Chemical Society, and requests the Presidents, Secretaries, and Committees of the said Societies to make the necessary arrangements for carrying this project into effect; and that in the meanwhile the President, Secretary, and Committee of the Tyne Chemical Society, not being previously members of the Newcastle Chemical Society, be invited to join in the deliberations of the Committee of the Newcastle Chemical Society, and that the members of the Tyne Chemical Society be invited to all the meetings of the Newcastle Chemical Society, and to read papers thereat."

In framing this resolution I have had regard to two objects: first, to effect an immediate *practical* amalgamation—for it will be observed that the members of the Tyne Chemical Society will enter at once into the enjoyment of all the advantages which appertain to membership of this Society; and, second, to avoid any infringement of the existing rules of this Society. The formal union will be left to the deliberate arrangements made by the Presidents, Secretaries, and Committees, who will find out how the end can be attained without disregard of order and rule. I have no doubt that the members present will see the desirability of securing this object, and it is perhaps unnecessary for me to say anything further.

Mr. Proctor—I rise to second Mr. Swan's resolution. I don't think I have anything to add to what he has said. The resolution is worded so carefully as to avoid any appearance of irregularity or disregard of the rules in force in either Society. It is difficult, after having constituted our Society and framed rules, to take upon ourselves a step so unusual without in some degree infringing these rules, and if we were to work precisely by the rules we should have to postpone the legal amalgamation till the October meeting next year; *practical* amalgamation is, however, effected by the resolution, and I think that the way to get over any difficulties will be to dissolve our Society at the time when the amalgamation takes place. I don't know that there is anything to prevent us from dissolving and re-organising.

The resolution was then put to the meeting, and carried unanimously.

The Chairman—There is no doubt, I think, as to the feeling of the meeting on the subject: I hope at our next meeting we shall see the members of the Tyne Chemical Society, and perhaps have papers from some of them. We have now to listen to a paper by Mr. Swan "*On the Smoke of an Electric Lamp.*"

Mr. Swan—When the time for discussion of Mr. Proctor's paper "On the Smoke of an Electric Lamp" came, I said I had then nothing to remark, but that I might afterwards have something to add to it, as I was experimenting on the subject. Therefore what I have is not a paper, but rather a few remarks in continuation of the discussion on Mr. Proctor's paper:—

At a recent meeting of the Society Mr. Barnard Proctor read a short paper "On the Smoke of an Electric Lamp." It will, I believe, be remembered that the lamp referred to consisted of a globe of glass (about 3 inches in diameter) containing a rod of carbon: the rod was 0·04 inch in diameter and 1·2 inch long. It was held in a central position in the globe by sockets of platinum attached to platinum wire, which passed through opposite sides of the globe, and were hermetically sealed in it. The globe was carefully exhausted of air by a Sprengel pump. A current of electricity had been passed through the carbon rod, which raised it to a state of intense incandescence, and even bent it in such a manner as suggested that it had perhaps been softened by the intense heat. After the lapse of about a minute, during which a light was emitted sufficiently brilliant to illuminate a room about 40 feet square, the intense heat to which the carbon had been raised communicated itself to the platinum sockets and melted them, and so caused an interruption of the electric current and extinction of the light. When the globe came to be examined it was found to be coated with a deposit having the appearance of carbon; but as it was difficult to imagine how carbon could have got there, it was desirable that it should be proved whether it was really carbon or not, and my friend, Mr. Barnard Proctor, took in hand to examine into the nature of the deposit. The result of that examination has already been laid before you, as I have mentioned, and you will remember that the deposit proved to be for the most part carbon. That was one point settled. Another point which remained to be settled was the question how the carbon deposit got where it was found—whether contrary to common belief carbon was volatile, or whether its transport could be explained in any other manner? The object of my notice is to state that this last point has also been settled. Experiments which I, with the co-operation of my friend Mr. Stearn, have recently made, conclusively prove that the deposit which occurs under the conditions described is due to the mechanical transport of carbon particles, the residual air contained within the globe being the medium. We find the less air there is left in the globe the less deposit takes place, and we have succeeded in so nearly exhausting some globes that no deposit whatever takes place after a long-continued ignition of the carbon rod. I hope to illustrate this fact experimentally next meeting.

Two globes were exhibited by Mr. Swan, one, which had been more highly exhausted than the other, showing much less deposit.

Mr. Proctor—It was very interesting to observe in one of the globes, when the carbon was intensely ignited, that the ingress of a little air through some minute leak in the apparatus caused little streams of smoke to circle rapidly through the globe, and these increased as the quantity of air increased. Chemically, we should expect the more air less smoke; and as the deposits became less as the vacua were made more perfect, I think there can be no doubt that the deposit was mechanically transported carbon.

Mr. Swan—The practical bearing of this is somewhat important, for if we can succeed in preventing absolutely the formation of this deposit, which now seems practi-

cable, we should have an electric lamp free from the irregularities of the present electric lamps.

Mr. STEVENSON—I feel very ignorant of the whole matter; but the question, as it appears to me, is—what is smoke? We are told that this deposit is not smoke, not volatilisation, yet it is transport of carbon: in what form is the carbon transported if not in the form of smoke?

Mr. SWAN—I don't think I used the term smoke in describing this appearance; but Mr. Proctor referred to smoke. I simply referred to the deposit, comparable to the deposit in a chimney, which is the result of smoke. The transport of particles is so slow that you don't see any smoke, but the glass gradually becomes coated with a deposit which consists of solid particles of carbon.

Mr. PROCTOR—I do think there is a distinction between this deposit and smoke. I should define smoke to be a deposit of carbon in the solid form from some body which contained it in the form of gas or vapour; but these carbon particles have never been in the gaseous condition, have been transported in the solid form, and are hence dust rather than smoke.

The CHAIRMAN—The discussion appears to resolve itself into the question, What is smoke? As Mr. Proctor says, smoke (ordinary coal-smoke at least) is a deposit of carbon from some gaseous hydrocarbon which has been imperfectly burnt. Now this process did not occur in the lamp, and hence the deposit cannot properly be termed smoke. It is a transmission through space of solid particles of carbon, and I think Mr. Swan said the less air the less deposit, and *vice versa*, which of course shows it could not be smoke in the ordinary acceptation of the term. The paper is one of a kind which gives value to the discussions of a society like ours, and forms one of the best arguments for its existence. It is an observation of an isolated phenomenon, out of which we never know what may come. Indeed Mr. Swan has already pointed out one practical result of the observation in the form of a steady electric lamp.

Prof. HERSCHEL—I think Mr. Swan has established the fact that the carbon was not volatilised, but mechanically transported. I should like to ask what kind of vacua is the deposit formed in? Is the exhaustion as high as in Mr. Crookes's apparatus for the exhibition of molecular streams, for instance? The transference of these carbon particles may be a manifestation of some kind of force similar to that which Mr. Crookes has discovered in the negative pole, and it may be dependent on the degree of exhaustion. Mr. Swan's explanation, however, appears the most rational I have heard.

Mr. SWAN—The original degree of exhaustion in the globe when sealed was about that of an ordinary Geissler tube. But there is occluded in the carbon, and possibly in the platinum, gaseous matter which is expelled at the high temperature of the lamp, and this reduces the vacuum to an unknown extent.

The CHAIRMAN—What was the gas which was occluded?

Mr. SWAN—That I cannot say.

Prof. HERSCHEL—Is the smoke produced in inert gas of ordinary atmospheric pressure?

Mr. SWAN—Yes, in a nitrogen atmosphere it is formed very readily.

The CHAIRMAN—We have next a paper by Mr. H. R. Procter.

"*Note on the Use of the Slide Rule for Chemical Calculations*," by HENRY R. PROCTER, F.C.S. I should perhaps apologise for bringing a matter before our Society which cannot in any sense be said to be new, and which no doubt is a perfectly familiar one to many of our members. But doubtless there are others who, like myself not long ago, have never actually used the instrument, however well they may know it by name; and as there are few devices which save more tiresome and routine labour, I may be excused for pressing it on their attention, and the more so because for our calculations its use is so simple that ten minutes' study will enable anyone to employ it, and to read at sight results which would take at least many minutes to work out on paper.

The slide rule in its simplest form, which for our purpose is all that is needed, consists of two sliding scales running from 1 to 10 or 1 to 100, and divided decimally in logarithmic proportions. It is of course the characteristic property of logarithms that their addition and subtraction is equivalent to the multiplication and division of the corresponding common numbers, and hence these processes may be performed by simple addition and subtraction of lengths on the scale. From this follows the fact that *any* question of "rule of three" (and under this category come *all* ordinary chemical problems) may be solved at sight by its aid. Let 2 on one scale be over 3 on the other, and 4 will be over 6, and 6·66 over 10, and so on throughout.

Supposing we want to know what weight of sulphur corresponds to 0·595 grm. of baric sulphate, we must say—

"As $\frac{BaSO_4}{233}$ is to $\frac{S}{32}$ so is 0·595 to answer," and multiply the second and third term together, and divide by the first."

To work it on the rule we set 32 over 233, and read the answer, 0·0817 grm., over 0·595, having saved the writing of at the very least thirty-two figures, and corresponding possibilities of error. Again, supposing 2 grms. of substance have been used in the analysis, all that is needed is to divide the atomic weight of S by 2, and set 16 over 233, and read the percentage of sulphur over any weight of $BaSO_4$ found.

Again, supposing we have to titrate anything with a standard acid not exactly normal,—say 978 c.c. equals 1000 c.c. of truly normal, all that is necessary is to set 978 on one scale above 1000 on the other, and under any quantity of acid used read the exact corresponding quantity of normal. It is obvious that we may in this way use any random standard solution almost as conveniently as a truly normal one, so long as its actual strength is known.

Another convenient plan, of almost universal application when a series of analyses with the same quantities and materials have to be made, is the following:—A single analysis is carefully calculated out in the usual way, either from actual results or from assumed ones chosen to facilitate the reckoning; and all others are reckoned, by simple proportion to this one, on the rule. This is accurate, however complicated the original calculation, provided all the conditions are really the same in each case, and is specially useful where random standard solutions must be used. To choose an instance familiar to myself, say 5 grms. of valonia are exhausted with a litre of water, 10 c.c. are used for titration with a permanganate (of which perhaps 49 c.c. correspond to 0 63 oxalic acid, or to 0.92355 of a suppositious tannin), and require 7·35 c.c. of the permanganate for oxidation. This naturally takes some calculating; but if I find that it corresponds to 30·4 per cent, I set 7·35 above 30·4, and in any succeeding analysis read the percentage direct below the c.c. of permanganate used.

It may be objected that a rule of moderate size will not read further than three figures, or per cents and one decimal, while it is customary to write two decimals of a per cent. It has, however, been shown in a previous paper ("On Errors of Weighing, and their Influence on Results," vol. ii., p. 187), that the errors, even of an excellent set of weights, completely vitiate the second place of decimals; so chemists who do not correct for these and the other unavoidable sources of error there pointed out, may guess at a second place with perfectly easy minds, assured that they are quite as likely to be right as if they had calculated it. Seriously, one place of decimals is for all practical purposes enough, except in cases of accurate determinations of scientific constants, where no trouble can be considered, and all possible corrections must be made. Even

in these cases the slide rule is invaluable for checking over the calculations, and often detects errors that might be passed over in simply going through the figures.

I do not know whether it is out of order to mention that the rule I use is made by Messrs. Tavernier and Gravet, of Paris, and supplied by Mr. Robson, of Dean Street; and for excellence and accuracy of graduation I have found it completely satisfactory. The price is from 8s. to 12s., the more expensive ones being provided with trigonometrical and other scales in addition to the simple logarithmic ones required for chemical purposes.

Two slide rules were exhibited by Mr. Robson at Mr. Procter's request, to illustrate the paper.

Mr. STEVENSON—I should strongly deprecate any chemist using this rule in place of ordinary arithmetical calculation, though I am quite ready to admit that it may be very useful as a check. I quite agree with Mr. Procter as to the uselessness of stating the second decimal; and if that were kept in mind we might save many unnecessary figures in calculations.

Mr. B. S. PROCTOR—Thirty years ago I used a scale such as Mr. Procter recommends, but eventually gave it up and took to arithmetical calculation. Multiplication is more accurate than the scale, if you don't make mistakes: while the advantage of the scale is that it never does make mistakes.

The CHAIRMAN—I remember that scales similar to these, but very much longer, used to be common many years ago in all the laboratories in this district, but latterly I have not seen any. We always used them, however, simply as a check on our own calculations.

Votes of thanks were then given to the authors of papers.

At the close of the meeting Mr. Swan exhibited a very sensitive dry plate. The plate was exposed under a negative to the light from a small bat's-wing burner at a distance of about 10 feet, for three-quarters of a minute; and on development produced an excellent positive, which had no appearance of insufficient exposure.

CORRESPONDENCE.

SIZING OF COTTON GOODS.

To the Editor of the Chemical News.

SIR,—The writer of your review of Mr. Thompson's work on sizing makes an assertion which (having appeared before in the newspapers) has misled a great number of cotton merchants and manufacturers with regard to the cause of mildew when chloride of magnesia is used for sizing purposes. In the review in question (CHEMICAL NEWS, vol. xli., p. 9) the writer says—"Some substances most largely used in sizing, such as China clay, have no tendency to foster mildew. Others, such as the chloride of magnesium, have this undesirable property *in virtue of the deliquescent nature, which keeps the tissue damp.* The more chloride of magnesium is used, the greater is the need for chloride of zinc." The portion of the above quotation which I take exception to is the part which asserts that chloride of magnesium fosters mildew in virtue of its deliquescent nature. This is only partially true, because if the phrase has any meaning it is that substances which are deliquescent will foster mildew. This is negatived by the very fact that chloride of zinc is as deliquescent as chloride of magnesium, yet the former prevents instead of fostering mildew. The fact is, that chloride of magnesium as a salt has no antiseptic property, or very little. When chloride of magnesium is used alone, it absorbs moisture, keeps the tissue damp, and having no antiseptic property it does not prevent the cloth mildewing. On the other hand, chloride of zinc also absorbs moisture and keeps the tissue damp; but the tissue does not mildew, because chloride of zinc as a salt has antiseptic properties. It is not generally known among cloth merchants and manufacturers that chloride of zinc *is a deliquescent salt* because it is sold in solution. Chloride of magnesium being sold in the solid condition, the user can see the rapid absorption of moisture for himself. In my articles on sizing* I have classified magnesic chloride as a weight-giving substance, in virtue of its power of absorbing moisture and its want of antiseptic property. Chloride of zinc is a weight-producing substance also, but it has powerful antiseptic properties as well.—I am, &c.,

GEORGE WHEWELL,
Author of "History of Sizing."

Regent Chambers, Blackburn,
January 6, 1880.

THE PETROLEUM ACT, 1879.

To the Editor of the Chemical News.

SIR,—It will be noted that the schedule of the Petroleum Act, 1879, which you recently published in your columns contains no description of the "lead-line or pendulum," referred to in the Directions for Applying the Flashing-test. Prof. Abel has, however, informed me, in reply to a letter pointing out the oversight, that "a pattern pendulum or lead-line, as a guide for the lengths of pendulum to be used in connection with the petroleum test, has been deposited at the Standards' Office, Old Palace Yard, with a label upon which is specified that the pendulum is two feet in length from the point of suspension to the centre of gravity of the weight."

Where large numbers of samples have to be tested, I would recommend the use of a metronome, such as is used in teaching music, adjusted to beat synchronously with the pattern pendulum, the distinct sound emitted at each oscillation forming, in my experience, a better guide than the noiseless swing of the lead-line.—I am, &c.,

BOVERTON REDWOOD, F.C.S., F.I.C.,
Chemist of the Petroleum Association.

January 14th.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 14, 1879.

On Polymerised Non-saturated Acids.—Rudolph Fittig.—The author's researches have been chiefly directed to isotropasic and cinnamic acids.

Action of Potassium Carbonate upon Isobutyl-aldehyd.—F. Urech. Continued from vol. xii., p. 193.—The author has examined the sparingly mobile liquids formed by this reaction at common temperatures.

Behaviour of Para-isobutyl-aldehyd with certain Reagents.—F. Urech.—The reagents in question are sulphuric acid, concentrated soda-lye, and chromic acid mixture.

Theoretical Considerations on the Polymers of Isobutyl-aldehyd.—F. Urech.—Incapable of useful abridgment.

Action of Iodine upon Oil of Turpentine.—H. E. Armstrong.—The mixture of hydrocarbons formed by the action of iodine and camphor—the so-called camphine of Claus—contains as its main constituent, in addition to cymol and higher homologues of the benzol series, a paraffin-like hydrocarbon of the formula $C_{10}H_{20}$.

* *Textile Manufacturer* vol. v., for April, May, June July, August, and September, 1879.

Action of Sulphuric Acid upon Hydrocarbons of the Formula $C_{10}H_{16}$.—H. E. Armstrong and W. A. Tilden.—The authors have examined tereben anew, and have succeeded in erasing it from the list of known compounds.

Formation of Cymol and of the Hydrocarbon $C_{10}H_{20}$ by the Action of Sulphuric Acid upon Terpens.—H. E. Armstrong.—These two constituents are chiefly, if not exclusively, formed by the action of sulphuric acid upon oil of turpentine.

On the Absolute Expansion of Liquid and Solid Bodies.—H. F. Wiebe.—For the entire scale of aggregate conditions one common law of expansion holds good. At the boiling- and the melting-points all substances possess an equal cohesion. If we therefore multiply the absolute expansion of the temperatures of these points, increased by the inverse coefficient of expansion (0·00365), we obtain comparable numbers which are all multiples of the coefficient of expansion. Probably the number of the atoms which combine to a liquid or solid molecular group stand in simple proportions in members of the same chemical group.

On Para-nitro-phenyl-acetic Acid.—T. Maxwell.—This compound, $C_8H_7NO_4$, is readily soluble in alcohol, ether, and benzol; sparingly soluble in cold, but readily in hot water. It melts at 151·5° to 152°. Several of its salts are here described.

Quantitative Determination of the Oxygen Dissolved in Water.—Ferd. Tiemann and C. Preusse.—Certain portions of this important memoir are given in full. (See p. 30).

Behaviour of Sulpho-chlorides with Amines.—W. Michler and F. Salathé.—The authors describe the mutual reactions of α-naphthalin sulphochloride and dimethyl-anilin; of fuming nitric acid upon α-naphthyl-dimethyl-amido-phenyl-sulphon; and of β-naphthalin-sulpho-chloride upon dimethyl-anilin.

Behaviour of Sulpho-Chlorides with Amines.—W. Michler and K. Meyer.—A continuation of the last paper.

Action of Nitrous Acid upon Mono- and Diethylen-diphenyl-diamin.—H. F. Morley.—An account of ethylen-diphenyl-dinitrosamin, dinitroso-diethylen-diphenyl-diamin, and diethylen-diphenylen-tertramin. The salts of the last-mentioned body, in solution, give with ferric chloride a deep violet colouration.

Certain Derivatives of Dimethyl Meta-toluidin.—C. Wurster and C. Riedel.—The authors describe nitroso-dimethyl-meta-toluidin, nitroso-cresol, nitro-dimethyl-meta-toluidin, brom-dimethyl-meta-toluidin, dimethyl-toluylen-diamin, and tetra-methyl-toluylen-diamin.

On Dimethyl-para-phenylen-diamin.—C. Wurster and R. Sendtner.—An investigation of the action of bromine upon dimethyl-para-phenylen-diamin, and the behaviour of nitrous acid upon the oxaminic-ethyl ether of dimethyl-para-phenylen-diamin.

Action of Oxidising Agents upon Tetramethyl-para-phenylen-diamin.—C. Wurster and E. Schobig.—An examination of the blue colouring-matter obtained by the above reaction. The authors describe the behaviour of nitrous acid with tetramethyl-para-phenylen-diamin, trimethyl-para-phenylen-diamin, the nitrosamin of nitro-trimethyl-para-phenylen-diamin, and, lastly, trimethyl-triamido-benzol.

On Tetramethyl-meta-phenylen-diamin.—C. Wurster and H. F. Morley.—Tetramethylated meta-phenylen-diamin is much more permanent than the corresponding para-compound, and does not yield the same colour-phenomena.

On Brom-dimethyl-anilin.—C. Wurster and A. Scheibe.—An account of the action of nitrous acid upon the brom-dimethyl-anilin melting at 55°, of the nitrosamin of monobrom-monomethyl-anilin. On the reduction of nitrosamin and monobrom-monomethyl-anilin with tin and hydrochloric acid there is formed a body which dissolves in alcohol with a red colour, and is probably a dimethylated rosein. Lastly, the authors describe meta-brom-dimethyl-anilin.

On Para-brom-dimethyl-anilin.—C. Wurster and A. Beran.—The authors obtain this compound by heating pure para-brom-anilin (melting-point 61°) in a closed tube in the water-bath, with somewhat more than 3 mols. iodmethyl and an excess of soda-lye.

Action of Nitric Acid upon Tribrom-benzol.—C. Wurster and A. Beran.—On treating tribrom-benzol with 10 parts of red fuming nitric acid (sp. gr. 1·534), the authors obtained mono-nitro-tribrom-benzol.

Ferro- and Ferri-cyanides of Certain Tertiary Bases, and of their Substitution-products.—C. Wurster and L. Roser.—Not susceptible of useful abstraction.

On Diastase.—M. Baswitz.—A study of the action of pressure, temperature, and concentration upon the action of diastase.

Solubility of Ozone in Water.—A. R. Leeds.—The author establishes the solubility of ozone in water, and shows that when in solution it displays its maximum oxidising power.

The Reduction of Carbonic Acid by Phosphorus at Common Temperatures.—A R. Leeds.—This reduction is accompanied with the formation of carbonic oxide and of hydrogen phosphide.

Oxidation of Carbonic Oxide of Air over Moist Phosphorus at Common Temperatures.—A. R. Leeds.—This reaction is established by the author's experiments.

Vapour Density of Stannous Chloride.—T. Carnelley.—The boiling-point of this salt was determined by Carleton Williams, and the author is the real cause of the low numbers (7·47 and 6·88) which Rieth obtained.

The Spontaneous Oxidation of Nitro-lactic Acid.—L. Henry.—The products are hydrocyanic acid, oxalic acid, and water.

Addition of Free Oxygen to Non-saturated Compounds.—L. Henry.—The author describes a case of such addition.

Dry Distillation of Sodium Trichlor-acetate.—L. Henry.—The products obtained are carbonic oxide, carbonic acid and phosgen gas, trichlor-acetyl-chloride, and as secondary products trichlor-acetic acid and its anhydride, and as by-products the chlorides of carbon, C_2Cl_4 and C_2Cl_6.

The Isomeric Toluol-mono-sulphonic Acids.—P. Claesson and K. Wallin.—The meta-acid is not, as Fahlberg states, a mixture of the ortho- and para-acids, but is perfectly well characterised.

On Guanidins of Ortho-toluidin and their Cyanogen Derivatives.—F. Berger.—An account of diorthotolyl guanidin, dicyan-diorthotolyl guanidin, diorthotolyl-oxalyl guanidin, diorthotolyl-parabanic acid, triorthotolyl guanidin, α-dicyan-triorthotolyl guanidin, triorthotolyl-oxalyl guanidin, and its behaviour with hydrochloric acid.

Ethylen Ethers of Pyrogallic Acid.—G. Magatti.—A notice of pyrogallic mono-ethylen ether, and certain of its derivatives.

Determination of Chromium and Tungsten in Steel and Alloys of Iron.—R. Schöffel.—(See p. 31.)

Determination of Cobalt and Nickel.—E. Donath.—(See page 15).

Substituted Chlorides of Nitrogen.—H. Kœhler.—Not adapted for abstraction.

Direct Production of Propylen-glycol from Glycerin.—A. Belchoubek.—This reaction is produced by the dry distillation of a gummy mass which remains after glycerin has been treated with sodium amalgam.

Molecular Re-arrangements of the Isobutyl Group. B. Brauner.—A speculative paper.

Action of Silver Cyanate upon Isobutyl-iodide.—B. Brauner.—The product consisted of two-thirds trimethyl-carbinol-amin and one-third isobutyl-amin.

Octyl Derivatives.—E. Eichler.—The author describes mercury dioctyl, mercury iodoctyl, chlor-mercury-chloride octyl, mercury octyl-hydroxide, dioctyl, nitro-octan-octyl-nitrolic acid, octyl-amin, and octyl cyanide.

Rectification Residues of the Distillation of the Tar of Lignites, and on Certain New Derivatives of Chryson.—A. Adler.—The derivatives in question are mono-nitro-chrysen, tetra-nitro-chrysen, bibrom-chryso-quinon, dinitro-chryso-quinon, tribrom-binitro-chrysen, and chryso-quinon bisulphate of barium.

The Serpentine Masses of Reichenstein, and the Minerals therein occurring.—R. Hare.—An enumeration of the minerals and an account of their composition.

Analysis of the Upper Well of Fleinsberg, in the Iserkamm, Silesia.—Th. Poleck.—The character of this paper may be judged from its title.

Detection of Organic Matter in Water.—F. Tiemann and C. Preusse.—(See p. 31).

Gazzetta Chimica Italiana.
Anno 9, Fasc. 8 and 9, 1879.

Cymen of Cuminic Alcohol.—E. Paterno and P. Spica.—The author's experiments leave no doubt that the hydrocarbon obtained by the reduction of the chloride of cymile is identical with the cymen of camphor, and the cymen obtained by Kraut on heating cuminic alcohol with zinc.

Brief Notice on Cymen-carbonic Acid.—E. Paterno and P. Spica.—The acid in question is formed by heating carbocymenic amide with hydrochloric acid to 180° in a sealed tube. It is isomeric with the homocymenic acid of Rossi, but melts at a higher temperature.

Decomposition of the Hydrochlorate of Ethyl-amin by Heat.—M. Fileti and A. Piccini.—The decomposition commences at 270°, and becomes more active about the melting-point of lead. The residue consisted of ammonium chloride and of unaltered hydrochlorate of mono-ethyl-amin, mixed with the hydrochlorate of di-ethyl-amin. The gases evolved were the chloride of ethyl and ethylen.

Gasometric Analyses and Gasometric Methods.—D. Amato and P. Figuera.—An examination of the gases given off from a lake in the Valle del Bove.

Artificial Amelioration of the Leaves of Indigenous Tobacco by causing it to Imbibe the Juices of Exotic Leaves.—Antonio de Negri.—The nature of this paper appears sufficiently from the title.

Action of Potassic Bichromate upon Acetic Acid and Potassic Acetate.—Dr. Leobaldo Danesi.—The carbon of the acetic acid is totally or partially burnt by the oxygen of the chromic acid, as is the case with formic acid. If potassic acetate is boiled with potassic bichromate the reaction is similar.

Phenol Tolylate.—Dr. G. Mazzara.—The author obtains this compound by heating chloride of tolyl along with phenol in presence of zinc powder.

Oxy-azo-benzin and Para-methyl-oxy-azo-benzin.—Dr. G. Mazzara.—An account of the preparation and properties of these two bodies.

Meta-amido-cinnamic Acid.—Dr. G. Mazzara.—The author obtains this acid by the action of hydrochloric acid and metallic tin upon the meta-nitro-cinnamic acid of Schiff.

Insecticide Powder of the Flowers of Chrysanthemum Cinerariæfolium (Trew).—Prof. G. Dal Sie.—A preliminary notice. The author describes certain other insecticide powders obtained from the leaves of various species of *Pyrethrum*.

Synthesis of Phenyl-cumarin.—Dr. A. Oglialoro.—The author obtains this compound, along with acetyl-phenyl-ortho-cumaric acid.

The Sulphacids of Cymen and a New Cymo-phenol.—Dr. Pietro Spica.—A lengthy paper, not susceptible of useful abstraction.

Artificial Production of Oligiste from the Lava of Vesuvius.—The author steeped fragments of lava in a concentrated solution of common salt, placed them in a bottomless crucible, and heated them over a Bunsen burner. After a few days of constant heating the pieces of lava became covered with hæmatite, whilst laminæ of oligiste were sparingly scattered over their surface.

Production and Oxidation of the Alcoholic Derivatives of Natural and of Synthetic Tymol.—E. Paterno and F. Canzoneri.—The alcoholic derivatives of synthetic tymol are more easily oxidised than the corresponding derivatives of crystalline tymol.

A New Organic Acid, the Lithobilic found in the Oriental Bezoar along with the Lithofellic Acid.—Dr. G. Roster.—The author ascribes to this acid the formula $C_{30}H_{58}O_6$.

A New Method of Preparing Phenol-glycolicic Acid, and on Pyro-gallo-tri-glycolicic Acid.—Dr. P. Giacosa.—The former acid may be obtained by heating together in the water-bath equivalent quantities of phenol and of mono-chlor-acetic acid, and gradually adding for each part of phenol 4 parts of soda-lye (sp. gr. 1·3). After the reaction is over the sodic salt of the acid is deposited as a crystalline mass.

Resistance of Seeds, and especially those of Lucerne, to the Prolonged Action of Gaseous and Liquid Chemical Agents.—Italo Giglioli.—This extensive memoir does not admit of abstraction. The author's experiments relate principally to the seeds of lucerne.

Lapacic Acid.—E. Paterno.—This acid is represented by the formula $C_{15}H_{14}O_3$. It is not a glucoside, and on treatment with bromine it is converted into a substitution product, $C_{15}H_{13}BrO_3$, which forms splendid orange-coloured laminæ. By nitric acid it is almost entirely converted into phthalic acid.

Colouring-matter of Cucumis Anguria and of the Tomato.—Antonio and Giovanni de Negri.—The colouring-matter in question, rubidin, is extracted from the fruits by means of ether, which dissolves it along with a yellow colouring-matter. The ether is evaporated away and the residue treated with anhydrous alcohol, in which the yellow compound dissolves, whilst rubidin is left undissolved in the form of small crystals.

Chemiker Zeitung.
No. 52.

Determination of the Proportion of Water in Alcohol.—Aug. Vogel.—The author utilises a property of the alcoholic solution of the sulphocyanide of cobalt, which is changed from a blue to a red colour on the addition of water. By adding a few drops of the blue solution to a mixture of equal volumes of water and of alcohol, of sp. gr. 0·830 (=87·7 per cent), the liquid is at once turned red. This change of colour is also produced by a mixture of 60 vols. alcohol and 40 vols. water, but if 80 vols. of the alcohol are added to 20 of water the liquid remains blue. The author believes that this method may be developed so as to give approximate results.—*Bayerisch. Indust. und Gewerb. Bl.*, ii., 372.

Quantitative Determination of Fats and Resins in Cements and Lubricants.—The mixture is heated upon the water-bath with a sufficient quantity of soda-lye and alcohol until thoroughly saponified. The alcohol is expelled by heat, the residue taken up in water, and decomposed with hydrochloric acid. When heated on the water-bath the fatty acids, which have been liberated, and the

resins collect together, and after cooling may be separated from the liquid, washed with cold water, covered with several vols. of water, and heated to 50° or 60° with the gradual addition of sodic bicarbonate in small portions. A soap is thus formed from the fatty acids and dissolves, whilst the resin floats in the liquid or is deposited on the sides of the vessel, and may be separated by filtration. The fatty acids in the solution of soap are determined in the usual manner.—*Pharm. Central Halle*, xx., 446.

Reimann's Färber Zeitung, No. 47, 1879.

Destruction of Vegetable Fibres Mixed with Wool.—After discussing the proposed use of the chlorides of aluminium and magnesium, the writer concludes that such methods are applicable only to a superior class of goods and are useless where much vegetable matter is present. The only processes of practical value at present are treatment with sulphuric acid, and with hydrochloric acid gas, where the neighbourhood will permit.

No. 1, 1880.

"Acid Rubin."—Dr. E. Jacobsen converts the hydrochlorate of rosanilin into a sulphacid by acting upon the anhydrous salt with chlorinised sulphuric acid, SO_2Cl. This compound is an exceedingly valuable agent for the production of sulphacids. It acts less violently than the fuming sulphuric acid commonly employed, and yet forms sulpho compounds with ease. The colouring-matter thus produced can be used in woollen and silk dyeing in acid baths, and can be advantageously associated with extract of indigo, &c., for the production of various browns, modes, &c.

La Croix Rouge. December, 1879.

Trichinosis.—This disease appears to become more prevalent. Italy, Greece, and it is believed other countries, have been induced totally to prohibit the introduction of American hams, bacon, &c.

NOTES AND QUERIES.

Drying Blood.—Can any of your numerous readers inform us of the best way to dry blood.—W. H. M. G.

ERRATUM.—In the notice of Letts's Diaries for 1880 in our last issue we should have said that this is the 70th year of publication instead of the 30th.

MEETINGS FOR THE WEEK.

MONDAY, 19th.—London Institution, 5.
—— Medical, 8.30.
TUESDAY, 20th.—Royal Institution, 3. Prof. Schäfer, "Physiology of Muscle."
—— Civil Engineers, 8.
—— Zoological, 8.30.
WEDNESDAY, 21st.—Society of Arts, 8. Henry Carr, "Domestic Poisons."
—— Meteorological, 7. (Anniversary.)
—— Geological, 8.
THURSDAY 22nd.—Royal Institution, 3. H. H. Statham, "Modern Architecture since the Renaissance."
—— Royal Society Club, 6.30.
—— Royal, 8.30.
—— Society of Arts, 8. Prof. Perry, "The Teaching of Technical Physics."
—— Zoological, 4.
—— London Institution, 7.
FRIDAY, 23rd.—Royal Institution, 8. Dr. Carpenter, "Sea and Land in Relation to Geological Time," 9.
—— Quekett, 8.
SATURDAY, 24th.—Royal Institution, 3. Prof. T. Rupert Jones, "Coal."
—— Physical, 3. Dr. O. J. Lodge, "On the Theory of Prof. Hughes's Induction Balance." C. N. Boys, 'On a Liquid Voltaic Arc." J. Fater "On a Talking Machine.

BURNDEN CHEMICAL WORKS, AND OTHER PREMISES, AT BOLTON, LANCASHIRE.

VALUABLE LEASEHOLD LAND, BUILDINGS, WORKING PLANT, MACHINERY AND APPARATUS FOR MANUFACTURING SODA ASH, SULPHURIC ACID, MURIATIC ACID, BLEACHING LIQUOR, SULPHATE OF COPPER AND BRONZE ASH; ALSO VALUABLE DYE WORKS, AND FOURTEEN MESSUAGES OR DWELLING-HOUSES.

LOMAX, SONS, & MILLS, will SELL by PUBLIC ACUTION (by order of the Mortgagees), at the THATCHED HOUSE HOTEL, New Market Place, in the City of Manchester, on Tuesday, the 20th day of January, 1880, at Two for Three o'clock in the afternoon (unless previously disposed of by private contract), subject to such conditions as will be then and there produced,—

ALL THOSE VERY VALUABLE AND EXTENSIVE CHEMICAL WORKS, situate in Burnden Street, Manchester Road, Bolton, in close proximity to the Lancashire and Yorkshire Railway, known as the

BURNDEN CHEMICAL WORKS,

consisting of Ore-breaking Shed, Pyrites and Sulphur Burning Houses, Sulphate of Copper Sheds, Salt Cake Shed and Store, Bronze Ash House, Chemical Shed, Rectifying and Cooling Houses, Loading Shed, Ash Sheds, Cooper's Shop, Ash Packing Place, Joiners' and Mechanics' Shops, Engine and Boiler-houses, Wheelwright's Shop, Smithy, Nitre Store, Stabling for 17 Horses, Provender Place, Hay and Straw Stores, Private and General Offices, Laboratory, Machine-house, Chimneys, and other erections; together with the Steam-boilers, Steam-engines, Millwright's Work, Steam, Gas, and Water Piping belonging thereto: and also the whole of the Working Plant, Machinery, and Apparatus set up, affixed, and belonging to the several departments of the said works and premises, and capable of manufacturing monthly upwards of 1000 tons of Soda Ash, Sulphuric Acid, Muriatic Acid, Bleaching Liquor, Sulphate of Copper, and Bronze Ash. The Working Plant consists of Black Ash Furnace, four Cast Iron Lixiviating Vats, Steam Jets, Liquor Wells, Liquor Settler, Evaporating Pan, Salting Down Pan, Soda Ash Finishing Oven, pair of Ash Crushers, and Rotating Sieve; 14 Pyrites Burners, two Nitre Ovens, Lead Concentrating Tower, three Vitriol Chambers and three Nitre Recovery Towers, Air Engine by Daglish and Co.; four Acid Eggs, four Liquor Cisterns, Boiling-down Pan, eleven Sulphur Burners, Vitriol Wash Tower, five Vitriol Chambers, and two cisterns, three Boiling-down Pans, Sixty Rectifying Furnaces, Salt-cake Pot and Roaster, eight Stone Acid Cisterns, and two Stone Condensing Towers, seven Stone Chlorine Stills, five Stone Bleaching Vessels, with Gearing and Agitators, Liquor Well, Stone Acid Cisterns, Lead and Iron Chemical Tanks, Feed Pump, Ore Grinding Mill, Riddling Machine, Copper Calcining Furnace, Wagon Hoist, Tramways and Turntable, Wash Tower, six Extracting Vats, Liquor Settler, two Precipitating Tanks, Copper Vat, Precipitate Roasting Furnace, three Evaporating Pans, thirteen Lead Crystallising Pans, Liquor Well, Steam Pump, Drying and Sampling Benches, two Boiling-down Pots and Furnaces, Drying Furnace, Boiling-down Pan and Furnace, Drainer and Well, Mortar Mill, Chaff-cutting Machine, Ten-ton Wagon Weighing Machine, and Office Fixtures; together also with the THREE PLOTS of LAND, forming the site thereof, and occupied therewith, and containing altogether 24,318 square yards, or thereabouts.

The Premises are Leasehold, and are held for the residue of three several terms of 990 years, 999 years, and 990 years, subject to three several ground rents amounting in the aggregate to £120.

The Buildings, which are brick-built and slated (the sheds being erected on brick pillars), are excellently adapted for the purposes of the business, a large sum of money having been expended in their construction (a considerable portion of such sum within the last few years), and are most eligibly situated, the Lancashire and Yorkshire Railway being immediately contiguous to the Works. Gas and Water Mains are laid throughout, and there is a never-failing supply of water for all purposes. Immediate possession can be had.

Also those valuable PREMISES, situate in Burnden-fold aforesaid (adjoining the last-described premises), formerly used as a DYE WORKS, with the STEAM BOILER, STEAM ENGINE, SHAFTING, GEARING, PIPING, and FIXTURES thereto belonging, which, with the ELEVEN COTTAGES adjoining, being Nos. 3, 5, and 7, Haslam-street, 11, 13, 15, and 17, and 9, 25, 27, and 29, Burnden-fold aforesaid, and the site whereof contains 1302 square yards, are held for residue of term 999 years, at yearly rent of £7 14s. 1½d., and are subject to a lease for five years, at the yearly rent of £70, and will be sold subject to such lease.

Also all those TWO MESSUAGES, or DWELLING-HOUSES and CELLAR, with the YARD, OUTBUILDINGS, and APPURTENANCES thereto belonging, situate and being Nos. 209, 211, and 213, Manchester-road, and 6 and 8 at the back, and known as Back Burnden.

Site, 248¼ square yards. Term, 999 years. Apportioned yearly rent, £2 2s. 10d.

The whole of the foregoing properties will, in the first instance, be offered for sale in One Lot, and if not so disposed of will then be offered in Two Lots, viz.:—

LOT 1. Land, Chemical Works, Dye Works, and Dwelling-houses.
LOT 2. The whole of the Plant and Machinery.

The Conditionsof Sale will be open for inspection at the Offices of Messrs. Holden and Holden, Solicitors, Bolton, seven days before the day of sale.

Full particulars of which will be given on application to Messrs. P. and J. Kevan, Accountants, 12, Acresfield, Bolton; the Auctioneers, 15, Wood-street, Bolton; Messrs. Richardson and Marshall, Solicitors, 18, Wood-street, Bolton; or to

Messrs. HOLDEN and HOLDEN.
Solicitors,
Bolton.

Post 8vo, pp. xii.-136, with Illustrations, cloth, 6s.

A TREATISE ON FUEL,

Scientific and Practical,

By ROBERT GALLOWAY, M.R.I.A., F.C.S.,

Vice-President of the Institute of Chemists of Great Britain; Author of "A Manual of Qualitative Analysis," &c., &c.

London: TRÜBNER and CO., Ludgate Hill.

GIMINGHAM'S IMPROVED SPRENGEL

AIR-PUMPS, with Multiple Fall Tubes and every recent improvement, including McLeod's Gauge, Barometer Gauge, Radiometer, terminals for testing non-conductivity of the vacuum, &c., &c.

L. Casella having arranged with Mr Gimingham for the sole manufacture of these pumps is prepared to supply them either in their simple form or with all or any of the accessories. Mr. Gimingham has engaged to examine each instrument, in order that no imperfect instrument may be sent away.

CROOKES'S RADIANT MATTER TUBES.—L. Casella has also the pleasure of stating that he is now able to supply the highly exhausted tubes illustrating Mr. Crookes's beautiful experiments on Radiant Matter, and guarantee their excellence, as each will be sent to Mr. Gimingham for examination before going out.

L. CASELLA, 147, Holborn Bars, London, E.C.

AMMONIACAL LIQUOR.

The Newest and Best Continuous Method for working large or small quantities of liquor. This method is an improvement on what is known as the "Coffey Still Process." The cost of plant is very much less than by the above process. It is also much more durable. The result in sulphate of ammonia is very large, every atom of ammonia gas being driven out of the liquor before it is liberated. *Small Working Models* to work about *Five Gallons per Day*, with every requisite, including steam boiler, &c., for working any ordinary gas liquor. Sent C.O.D., with instructions, price £4 4s. Price for erecting, or for plans and specifications of large plant on application.

JOHN G. HARVEY,
Ethel Terrace, Milnsbridge, Huddersfield.

Silicates of Soda and Potash in the state of Soluble glass, or in CONCENTRATED SOLUTION of first quality, suited for the manufacture of Soap and other purposes supplied on best terms by W. GOSSAGE and Sons. Soap Works, Widnes, Lancashire.

London Agents, COSTE and Co., 19 and 20, Water Lane, Tower Street, E.C., who hold stock ready for delivery.

DAHL & CO.,
BARMEN (RHENISH PRUSSIA),

MANUFACTURERS OF

ANILINE AND NAPHTHALINE COLOURS.

SPECIALITY—Ponceau Naphthol-Reds as a Substitute for Cochineal.

Sole Agency and Depôt in England,

THEODOR BANG,

BENSON'S BUILDINGS, BASINGHALL ST., LEEDS.

THOMAS ADKINS & CO.,
SMETHWICK,
NEAR BIRMINGHAM

Manufacturers of Specially Prepared Red Lead for Flint-Glass Making.

Wanted, the names of Sellers of Perchloride of Iron.—Apply, W. and H. M. Goulding, Limited, 25, Eden Quay, Dublin.

FOR SALE, a large quantity of Copper Pyrites, in Bergen, Norway. Copper 5 per cent. Offers wanted —Apply, Nils Peter Larsen, Bergen, Norway.

Fletcher's | Solid Flame | Burner.
(TRADE MARK)

Will with equal ease boil an egg in a small tin saucepan or me l half a hundredweight of lead in an iron pot. It will boil half a gallo n of water in a flat copper kettle in five minutes, and will melt si x pounds of lead or solder in an iron ladle in seven minutes. Heigh t, 5 inches. Price, in galvanised iron, 4s. 6d. Complete list of Ga s Furnaces for all purposes; hot and cold blast blowpipes; automatic, foot, and hand blowers; instantaneous water heaters, &c.. on appli cation.

THOS. FLETCHER,
MUSEUM STREET, WARRINGTON

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

JESSE FISHER & SON,
Phœnix Chemical Works Ironbridge.

NEWTON, KEATES, & CO.,
Sutton Oak Manure Works,
ST. HELENS
LANCASHIRE,

MANUFACTURERS OF

PHOSPHATE OF SODA.

TOWNSON & MERCER,
89, Bishopsgate Street Within,
LONDON.

Wholesale and Export Dealers nd Manufacturers of

CHEMICAL & SCIENTIFIC APPARATUS
PURE CHEMICALS, &c.,

For Analysis and the general Laboratory Use of Manufacturers and Professors of Universities, Schools, Mines, &c.

Now ready,

TOWNSON & MERCER'S COMPLETE CATALOGUE of Chemical and Scientific Instruments, Pure Chemicals &c. Demy 8vo. Illustrated with upwards of 800 Woodcuts. Price 2s. post free.

POLYTECHNIC.—MARY QUEEN OF SCOTS.—The principal events in the life of the beautiful and unfortunate Mary Stuart, illustrated by Tableaux Vivants. The descriptive poem recited by Miss Alice Burnelle. The appropriate vocal music by a Choir of Glee Singers, under the direction of Mr. Stedman, daily at 3.30 and 8.30; Edison's Loud Speaking Telephone, &c., by Mr. Daniel, 10.30; the Zulu War and the Heliograph, by Mr. King, 11; London as it Was and Is, 11.30 and 8; the Electric Light, 12; Instrumental Concert by the Paggi Family, 2.30 and 7.30; Popular Optical Lecture, 3, by Mr. King: Phenomena of Light and the Ghost; by Mr. King, 6.30. Open 10 till 1, 2 till 5, and 6 till 10. Admission 1s. Reserved Seats, 2s., 1s., and 6d.

THE CHEMICAL NEWS.

VOL. XLI. No. 1052.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 28.)

THE constitution of uranium compounds again gives rise to numerous doubts, although the classic work of Péligot has cleared up the most important points of the history of this element. The formula of the oxide, such as was announced by him, and as is generally accepted, is Ur_2O_3, and its atomic weight is 120. In admitting these as true we cannot give uranium any determinate place in the system, either according to its atomic weight (for from Ag = 108 to I = 127 there is no empty place in the seventh series), or according to its properties; all the properties of uranium are even in opposition to the generally accepted hypothesis on the subject of its atomic weight. Although slightly resembling, in some of its properties, the metals of the iron group (particularly by its property of forming oxides, UrO, Ur_2O_3, Ur_3O_4), uranium is distinct from them on several points; its density is 18·4; it gives a volatile chloride, $UrCl_2$; its oxide only gives salts corresponding to the composition UrOX, and not UrX_3; having a higher atomic weight than iron it is more difficultly reducible than this metal; the basic properties of the oxide are more feeble than those of oxide of iron. These considerations lead us to imagine that uranium has a different atomic weight to that which was mentioned above. In starting, as I explained fully in the case of indium, from the known equivalent (40 for Ur, which nearly corresponds with 38 for In), we find that Ur ought to be in the sixth group, and that, therefore, the oxide ought to have the formula UrO_3, and the element should have for atomic weight 240. If so, its place is in the twelfth group, where thallium is. The greatest objection that we find here is that oxide of uranium is as rich in oxygen as we have only been accustomed to find the acid oxides.

1. The atomanalogues of Ur (in the even series) are—Th = 230, with a strongly basic oxide, ThO_2; and Cr, Mo, and W, which, like Ur, give oxides like RO_3. In these oxides, as in those of the other groups (see Chapter I.), the basic character increases and the acid character diminishes as the atomic weight increases. Thus the acid properties are more sharply defined in CrO_3 than in MoO_3 or WO_3. We can see already that MoO_3 and WO_3 have less acid properties, inasmuch that these oxides are capable of forming different salts with several acids, and with phosphoric, silicic, or sulphuric acid, they give bodies analogous to salts.*

We also notice more acid properties, less marked, it is true, in oxide of uranium. The following facts give us the proof of it:—

2. The precipitates formed by the caustic alkalies in solutions of salts of oxide of uranium are not hydrated oxides, but definite compounds of oxide of uranium with the alkalies. From this is derived the name *uranic acid*, by which name oxide of uranium is sometimes called. The composition of precipitates containing alkalies, $R_2Ur_2O_7$ (Ur = 240), corresponds completely with the composition of the bichromates, and of corresponding salts of molybdic and tungstic acids. The alkaline salts of oxide of uranium do not separate from the alkali, either under the influence of water or of acids.

3. The acid character of oxide of uranium betrays itself already in the ordinary composition UrO_2X_2 of all the salts that this body gives. X means an acid residue, Ur = 240. These salts, according to their composition, ought to be considered as basic, although they possess strictly acid properties; they recall at the same time the acid chloranhydrides corresponding to—

$$WO_2Cl_2,\ WO_2F_2,\ MoO_2Cl_2.$$

UrO_2Cl_2 is decomposed by water; and so is the double salt, which crystallises easily, $R_2UrO_2Cl_4,2H_2O$. The double salt just mentioned will only crystallise in an excess of HCl; therefore it corresponds to TiK_2Cl_6 and to other analogous compounds of the acid chloranhydrides.

4. Oxide of uranium gives perfectly crystallisable double salts, such as—

$K_4UrO_2(CO_3)_3$; $KUrO_2(C_2H_3O_2)_3$; $K_2UrO_2(SO_4)_2,2H_2O$, &c.

The salt of oxide of uranium in these double salts apparently plays the rôle of an acid element (as in—

$$2K_2CO_3 + UrO_2CO_3).$$

5. The acid character of uranium is corroborated by the volatility of chloride of uranium, $UrCl_4$ (Ur = 240). Another circumstance which confirms this character is that this latter, like the acid chloranhydrides, is decomposed by water, so also are $MoCl_4$, $TiCl_4$, $SnCl_4$, and $ThCl_4$.

We can further offer the following considerations to point out the necessity and the advantages of a modification of the atomic weight of uranium.

The atomic volume of Cr = 7·6, of Mo = 11, of W = 10,

$$\text{of Ur} = \frac{240}{18{\cdot}4} = 13;$$

the atomic volume therefore increases absolutely the same as in the other groups, according as the atomic weight increases. It is thus that the atomic volume increases rapidly in the group K, Rb, Cs; less in Ti, Zr, Th; still less in Fe, Ru, Os, &c.; until at length the atomic volumes of Cl, Br, and I are nearly equal.

We can establish the following proportion for uranium (see Chapter I.):—

$$Ur : Th = Pb : Hg = Te : Sn;$$

for, although these elements belong to different groups, that is to say, they form oxides of different formulæ, the chloric compounds of each couple have similar composition and properties. $UrCl_4$ is analogous to $ThCl_4$, so is $PbCl_2$ to $HgCl_2$, and so is $TeCl_4$ to $SnCl_4$.

The salts of suboxide of uranium are not isomorphous with the salts of magnesia, as we might think they were if we adopted the generally-accepted atomic weight, and according to which uranium would be analogous with iron. This difference is seen distinctly by suboxide of uranium forming a double salt, $UrK_2(SO_4)_3,H_2O$, with sulphate of potassium. In this formula Ur = 240. We see that for 2K there is $3SO_4$ and not $2SO_4$, as in the salts of the magnesia group.

When chloride of uranium ($UrCl_4$) is calcined in hydrogen it gives a body containing more than its half of chlorine. This phenomena is explained if we admit the possibility of the formation of $UrCl_3$ or Ur_2Cl_3, and it remains unexplained if we keep the accepted atomic weight (120) for Ur, because it is difficult to believe that Ur_2Cl_3 can be formed from $UrCl_2$.

Regnault found that the specific heat of suboxide of uranium (which was thought to be the metal) is 0·062. If we admit the formula for the suboxide to be UrO (Ur = 120), the molecular heat of this body is—

$$136 \times 0{\cdot}062 = 8{\cdot}4,$$

that is to say, it is less than that of ZnO (10·1) or of HgO (11·2), although the atomic weight of uranium is comprised, according to the above-mentioned hypothesis, between the atomic weights of Hg and Zn.*

If, on the contrary, we adopt the doubled atomic

* Phosphoric acid has nearly the same relation with oxide of uranium as it has with molybdic and tungstic acids, which leads us to compare these three last oxygenated compounds with the first. For further information on this subject, see my "Principles of Chemistry" (in the Russian language), vol. ii., p. 281 to 285.

* See my observations on the subject of specific heat in the "Principles of Chemistry," Second Part, Chapter III. Also my memoir published in the *Journal de la Société Chimique Russe*, 1870; and an abstract in the *Zeitschrift für Chemie*, 1870, p. 200.

weight, and if we give the formula UrO_2 to the suboxide the molecular heat = 16·9; it is, then, as we might expect, greater than the molecular heat of MnO_2 (13·8), and of SnO_2 (14·0), and less than that of $PbCl_2$ (18·5). The determination made by Regnault is then more favourable to the formula RO_2 than to the formula RO (for the suboxide of uranium).

The proposed modification of the atomic weight of uranium makes us regard nature and her works from a new point of view, and it invites new researches on the degree of analogy with Cr, Mo*, and W.

The following experiments seem to me to be particularly interesting:—

1. To determine the specific heat of metallic uranium. I have long been wishing to make this determination, but H. Bauer and I, who worked together, have not been able to prepare cast-uranium; we always obtained it in the state of powder. Not being sufficiently convinced of the purity of this product I did not think it good enough for this determination.

2. Find the vapour-density of volatile chloride of uranium.

3. Observe exactly how it behaves when red-hot in the presence of hydrogen.

4. Examine the salts of suboxide of uranium, and see if they are not isomorphous with the corresponding salts of ThO_2, SnO_2, ZrO_2, TeO_2.

5. Compare the crystalline forms of the corresponding compounds of UrO_3, MoO_3, and WO_3. It would be particularly interesting to pursue the study of $R_2UrO_2F_4$ (Carrington Bolton), and to make it the object of as complete a work as Marignac did on $R_2WO_2F_4$.

6. We can foresee the existence of a soluble oxide of uranium (metoxide) corresponding to the modifications of molybdic and tungstic acids.

7. It would be very interesting to submit the physical properties of corresponding compounds of Cr, Mo, W, and Ur to a comparative study, because we notice a great analogy in the composition, and even in the colour of corresponding compounds, above all of Cr and of Ur.†

The interest presented by a new study on uranium becomes greater if we modify the atomic weight in the manner indicated, because in this case the atom of uranium would become the heaviest of all known elements. I have arranged below the formulæ of some of the compounds of uranium according to the present atomic weight, and the values that they would have if the atomic weight were doubled:—

Ur = 120.	Ur = 240.
Compounds of protoxide—	
Ur_2Cl_3; Ur_4O.	$UrCl_3(Ur_2Cl_6?)$; Ur_2O_3.
Compounds of suboxide—	
$UrCl_2$; UrO.	$UrCl_4$; UrO_2.
$UrSO_4,2H_2O$.	$Ur(SO_4)_2,4H_2O$.
$K_2Ur_2(SO_4)_3,H_2O$.	$K_2Ur(SO_4)_3H_2O$.
Green oxide—	
$Ur_3O_4 = UrOUr_2O_3$.	$Ur_3O_8 = UrO_2,2UrO_3$.
Analogous to—	Analogous to the blue oxide of molybdenum.
$FeOFe_2O_3$.	$MoO_2,2MoO_3$.
Compounds of the oxide—	
Ur_2O_3; $UrOCl$.	UrO_3; UrO_2Cl_2.
$UrO(NO_3)_2,3H_2O$.	$UrO_2(NO_3)_2,6H_2O$.
$2UrONO_3,3H_2O$.	$UrO_2(NO_3)_2,3H_2O$.
$Ur_2O_2(NH_4)_4(CO_3)_3$.	$UrO_2(NH_4)_4,(CO_3)_3$.
$UrO(C_2H_3O_2)H_2O$.	$UrO_2(C_2H_3O_2)_2,2H_2O$.
$Ur_2O_2(C_2O_4),3H_2O$.	$UrO_2(C_2O_4),3H_2O$.

(To be continued.)

* In pointing out the experiments, based on the periodic law, which I think would be interesting to undertake, I do not claim the right of priority for doing them.

† This fact and some other also (the analogy of Pt and Pd, of Nb and Ta, &c.) suggest the idea that independent of the large and small periods there are still quadruple periods, formed of two large periods. If so, the elements of the sixth group ought in reality to pass from the eighth series to between Cr and Ur. If so, we can explain in a more satisfactory manner, some differences between MoO_3 and CrO_3, as well as the analogy of MoO_3 with WO_3.

ON CHEMICAL REPULSION.*

By EDMUND J. MILLS, D.Sc., F.R.S.

While engaged in some researches on the propagation of chemical change, I have incidentally encountered a new order of phenomena, which the title "chemical repulsion" may serve provisionally to designate. A brief outline of the experiments is given in the following paragraphs.

Upon a glass plate, laid in a horizontal position, is poured enough solution of baric chloride to cover it completely to a considerable depth. On this solution is placed another glass plate, provided with a small centre perforation; when the two plates are firmly pressed together with the hands, most of the solution is extruded, and only a very thin layer of it left between the plates. All excess of the solution having been removed from the outer surfaces of the plates as well as from the perforation, some dilute hydric sulphate is now introduced into the perforation. This reagent attacks the baric chloride, throwing down a white precipitate of sulphate; and, proceeding partly by diffusion, partly by flow, does not cease to widen in every direction its figure of advance, until the edges of the plates are attained. If the perforation is circular, the figure of advance is circular; in other words, the chemical development of a circle is a circle.

Let us now suppose the two plates to be square and equal, and let the upper one have two circular perforations, equidistant from the centre of the square, and situated upon its diagonal. Let also two circular developments of baric sulphate be caused to proceed, as before, from the two perforations simultaneously. At first, nothing remarkable is observed, but in a short time, the two growing circles begin to exercise a visible retardation on each other's progress; so that the figure of advance is no longer circular, but oval. [This retardation is of course observed only between the perforations; and not outside them, where the motion is entirely free.] As the development of the figures continues, so also does the retardation at their neighbouring edges increase; the final result being (however long the experiment may be prolonged), that the other diagonal of the square is completely and permanently traced out in a line of no chemical action.

The above experiments are of fundamental importance, and they obviously admit of endless variety. Of this, a few illustrations may suffice.

If the upper plate have three perforations, situated on the points of a central equilateral triangle, there are three repulsion lines; these end at the centre of the triangle, where they form a trilocular point, and traverse its sides midway at right angles.

When the upper plate has four perforations, situated on the points of a central square, there are four repulsion lines; these end at the centre of the square, where they form a quadrilocular point, and traverse its sides midway at right angles.

A very beautiful modification of the preceding experiment consists in simultaneously developing a circle from a (fifth) central perforation. This last circle has no means of escape from the surrounding four. The result is that it eventually forms a square figure bounded by repulsion lines, and having four symmetrically situated repulsion lines at its corners.

It is easy to demonstrate that the chemical repulsion in these experiments does not depend upon flow. Two superimposed triangular plates for instance, in neither of which is any perforation, give three repulsion lines on immersion in dilute hydric sulphate. From each corner a line proceeds midway (if the triangle be equilateral) to the centre. In this effect, diffusion is alone concerned.

In addition to hydric sulphate and baric chloride, other pairs of reagents may be used with success; and I anticipate no difficulty in obtaining results in which precipitation is not concerned. A beginning has also been made with experiments in tridimensional development.

* Abstract of a paper read before the Royal Society, Jan. 15, 1880.

The complete explanation of what I have termed "chemical repulsion," will probably demand a varied and considerable amount of experimental work. From some incidents of the investigation, so far as it has hitherto proceeded, I am disposed to believe that the motion in any plane chemical figure is not along the radius, but at right angles to the radius; and this supposition will, if verified, explain the repulsion. The existing results afford proof of the following propositions, viz.:—(1.) *Chemical action can take place at a distance;* and (2.) *Two or more chemical actions, identical except in position, completely exclude one another.*

ON THE

HEATING POWER OF COAL-GAS OF DIFFERENT QUALITIES.*

By Dr. W. WALLACE,
Gas Examiner for the City of Glasgow.

THE extensive employment of coal-gas for heating purposes, and especially for cooking, gives an interest to the question whether the heating power varies like the illuminating power, and if so, to what extent, in the gas used in different towns? As regards illuminating power, we know that it varies exceedingly. In Aberdeen and Edinburgh it is 30 candles for 5 cubic feet per hour; in Glasgow, Paisley, and Greenock, about 26 or 27 candles; in Liverpool, Manchester, and Carlisle, about 20; in London and Dublin, 16; in Birmingham and many other English towns, 14; and in some as low as 12 candles. But as regards heating power we have no definite information, although there is a general belief that a rich gas has a greater calorific effect than one of poorer photogenic quality.

My attention having been directed to the subject by a correspondent, I caused a small apparatus to be made, in order, when opportunity offered, to test the matter practically. It is of very simple construction, consisting of a cylindrical tin-plate vessel, 8 inches in diameter and 6 inches high, with a cylindrical opening in the centre, 1½ inches in diameter, through which the whole of the products of combustion pass. It contains exactly one gallon of water. Below is a brass tube bent into a circle 5 inches in diameter, and pierced with 34 small holes, from which the gas burns with flames about ¾ of an inch high. This tube is placed 1 inch from the bottom of the vessel, and is surrounded by an outer case having a sufficient number of small holes for the admission of air. On the top of the vessel there are two openings, in one of which a delicate thermometer is placed, while the other is provided with an open glass tube.

The opportunity of using the apparatus occurred recently, when I had occasion to test, on the same day, three samples of coal, which gave gas of 33, 26, and 15 candle-power respectively. Each experiment occupied, as nearly as possible, thirty minutes, and consisted in raising one gallon of water from 60° to 160° F., and measuring the quantity of gas consumed in the operation. The system is by no means a perfect one, but the results are strictly comparative. These are arranged in the following table:—

Illuminating Power of Gas in Standard Candles.	Durability of 1 C. Foot by flame 5 inches high. Mins.	Secs.	Specific Gravity Air=1000.	Comparative Value for Lighting.	Gas consumed in Heating Experiment. Cub. Ft.	Heat Units Fahr. for 1 C. Foot.	Comparative Value for Heating.
33·07	64	45	574	4/10	1·916	522	4/5
26·24	54	40	525	3/10	2·200	455	3/10
14·75	39	35	442	2/2	2·888	347	2/11½

* Read at the Meeting of the Philosophical Society of Glasgow, December 3, 18, 9.

The heat units represent the number of pounds of water heated 1° F. by the combustion of one cubic foot of gas. I have taken Glasgow gas of 26 candles at 3s. 10d. per 1000 cubic feet as the standard of value, and it will be seen at a glance that, while the heating value rises and falls with the lighting value, the amount of difference is by no means so great in the former as in the latter.

Having made these simple but instructive experiments, I naturally wished to compare the results with the theoretical heating values obtained by calculation from the composition of the gases. Unfortunately, I had no apparatus at the gas-works where the experiments were made for analysing the gases, and the best I have been able to do is to make the calculations from two analyses by the late Dr. Letheby, one of 12 candle gas, and the other of London Cannel gas, the illuminating power of which is not stated, but which may be assumed to be somewhere between 22 and 23 candles. The analyses are given only, as is usual with gaseous mixtures, by volume, but I have, for convenience, calculated the composition by weight.

	Common Gas. 12 Candles. Vol.	Wt.	Cannel Gas. 22 Candles. Vol.	Wt.
Olefiant gas, &c., C_2H_4 ..	3·8	9·5	13·0	24·9
Marsh gas, CH_4	39·5	56·5	50·0	54·8
Hydrogen	46·0	8·2	27·7	3·8
Carbonic oxide	7·5	18·7	6·8	13·0
Carbonic anhydride	0·6	2·4	0·1	0·3
Nitrogen	0·6	1·5	0·4	0·8
Aqueous vapour	2·0	3·2	2·0	2·4
	100·0	100·0	100·0	100·0
Specific gravity (calculated)	387		506	
Weight of a cubic foot in pounds ..	0·0296		0·0387	
Calorific power, C.	11,790		11,754	
,, ,, F., pounds of water heated 1° by the combustion of 1 pound of gas	21,222		21,157	
Heat units for 1 cubic foot, C.	345		455	
,, ,, ,, ,, F.	621		819	
Pounds of boiling water evaporated by 1000 cubic feet of gas	639		842	

We see from this tabular statement that, while the heating power of the two gases is almost identical, weight for weight, the practical result when we take the same measure of gas is very different, the Cannel being much heavier than the common gas. I calculate that in my practical comparative test I have realised about 55 per cent of the theoretical heating power, which is pretty nearly the proportion of effective heat obtained by the combustion of coal in a fairly well-constructed steam boiler.

The question naturally suggests itself, What is the comparative cost of heating by gas and coal? The calculation is a simple one. The theoretical heating power of ordinary soft coal may be taken at 13, that is, the number of pounds of boiling water evaporated by 1 lb., equal to 29,120 lbs. for a ton of coal, value say 11s. 6d., being the price of 3000 cubic feet of Cannel gas, the heating power of which is, say 2500. The gas, therefore, costs 11½ times as much as the equivalent quantity of coal, or, in round numbers, a penny-worth of coal gives as much heat as a shilling's-worth of gas. When, however, we consider the handiness, the cleanliness, and the convenience of gas, it is not surprising that it is extensively employed as a source of heat, as an illustration of which I may state that in my own laboratory from 250,000 to 300,000 cubic feet are consumed annually, almost the whole of which is burned for the production of heat.

The Royal Institution.—Prof. Dewar, M.A., F.R.S., will begin a Course of Eight Lectures on "Recent Chemical Progress," next Thursday afternoon, Jan. 29, at the Royal Institution.

DETERMINATION OF SILVER IN GALENA.

By C. BALLING.

According to the supposed proportion of silver, from 3 to 5 grms. of the ore, finely powdered, are well mixed with three to four times their weight of a flux made up of equal parts of soda and saltpetre. The mixture is introduced into a porcelain crucible of suitable size, covered, and heated over the lamp till the contents are melted, when the mixture is thoroughly stirred up with a glass rod. It is then allowed to cool, and the crucible is placed in a capsule partly filled with water. The softened melt is then removed from the crucible into the capsule, heated over a lamp, and the aqueous solution is filtered. The residue on the filter, after being well washed, is rinsed back into the same capsule, mixed with dilute nitric acid, and evaporated to dryness: the dry residue is taken up in water acidulated with nitric acid, heated over a lamp, and filtered into a flask, washing well with hot water. The filtrate is allowed to cool in the flask, mixed with ferric sulphate or iron-alum, and titrated with a solution of ammonium sulphocyanide according to Volhard's process, 1 c.c. of the solution representing 1 m.grm. silver. The presence of small quantities of copper is not objectionable; lead is even advantageous, as the sulphate of lead which is deposited shows the approach of the final reaction. Large proportions of iron interfere with the accuracy of the process. The treatment of galena with nitric acid does not effect the complete solution of the silver present.—*Oest. Zeitschrift Berg. u. Hütten.*

DETECTION AND DETERMINATION OF NITROUS ACID IN DRINKING-WATER, ACIDS, &c.

By A. R. LEEDS.

Concerning Griess's method, as further developed by Preuss and Tiemann, in which the nitrous acid is colorimetrically determined by means of meta-di-amido-benzol, the author remarks that the colours obtained with this reagent in acidulated solutions of nitrites very closely resemble dilute solutions of caramel, and proposes (as he formerly did for the colorimetric determination of ammonia by the Nessler test) the use of a hollow prism filled with a dilute solution of caramel, so as to give a scale of the colours produced by meta-di-amido-benzol in nitrite solutions of known strength, and to use this prism instead of comparative solutions.

On examining Trommsdorff's method of determining nitrous acid colorimetrically after admixture with zinc-iodide-starch solution and sulphuric acid, Prof. Leeds finds that in the dark, with free access of air and with equal proportions of acid the quantity of the iodine liberated increases with the proportion of dissolved iodide, whilst in the light the more iodine is liberated according to its intensity and its time of action. If air is absolutely excluded, light produces no decomposition, even at temperatures above the boiling-point. As the upper limit of the applicability of the reaction, the author gives 0·05 or 0·04 m.g. N_2O_3 in 100 c.c. In exceedingly dilute solutions the colorimetric determination is less accurate. According to Kübel and Tiemann, the water to be tested by Trommsdorff's method should contain not more than 0·04 and not less than 0·01 N_2O_3 in 100 c.c. Tinctorial organic bodies have an especially disturbing effect upon the reaction, as they not merely mask the changes of colour, but consume a part of the oxygen necessary for decomposing the iodides in the acid solution. Solutions of nitrites which are colourless and free from organic matter may be determined colorimetrically, but in coloured solutions and in presence of organic matter the air must be completely withdrawn and a volumetric method applied. The method employed by Prof. Leeds for the latter purpose is very simple, and consists of two comparative tubes fitted up with stoppers and tubes like washing-bottles. The exit-tube of the first, in which the reagents are placed, can slide up and down. The liquid to be examined is placed in the second vessel, through which carbonic acid, previously washed in potassium iodide, is passed for an hour, so as to expel all the air. The potassium iodide solution and sulphuric acid are driven from the first vessel into the second by sliding down the exit-tube, and a slight current of carbonic acid is passed for a considerable time through the liquid to prevent the action of the air. The iodine liberated is titrated with sodium hyposulphite. It is absolutely necessary that all air must be expelled from the liquid before adding the reagents.—*Zeitschrift Anal. Chemie* and *Chemiker Zeitung.*

COMPOSITION AND QUALITY OF THE METROPOLITAN WATER.

December, 1879.

The following are the returns of the Society of Medical Officers of Health:—

	Appearance in 2 foot Tube.	Ammonia. Saline.	Ammonia. Organic.	Nitrogen as Nitrates, &c.	Oxygen used to Oxidise Organic Matter.	Total Solids.	Lime.	Magnesia	Chlorine	Sulphuric Anhydride.	Hardness on Clark's Scale. Before Boiling.	Hardness on Clark's Scale. After Boiling.
		Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Grs.	Degrees	
Thames Water Companies.												
Grand Junction	Clear	0·000	0·008	0·195	0·060	22·50	7·160	0·329	1·224	1·330	15·4	4·2
West Middlesex	Clear	0·000	0·008	0·210	0·056	22·90	7·840	0·396	1·152	1·200	15·4	4·2
Southwark and Vauxhall	Clear	0·000	0·008	0·180	0·049	23·10	7·890	0·360	1·152	1·200	14·8	4·2
Chelsea	Clear	0·000	0·008	0·180	0·052	21·10	7·896	0·432	1·152	1·200	14·3	4·2
Lambeth	Clear	0·000	0·008	0·180	0·052	22·10	7·400	0·360	1·152	1·330	14·3	4·2
Other Companies.												
Kent	Clear	0·000	0·004	0·450	0·012	31·10	10·810	0·576	1·944	2·700	21·2	7·0
New River	Clear	0·000	0·007	0·200	0·023	21·90	7·890	0·360	1·152	1·200	13·7	3·7
East London	Clear	0·000	0·008	0·195	0·073	23·50	7·840	0·468	1·296	1·330	14·8	4·6

The quantities of the several constituents are stated in grains per imperial gallon.

Note.—The amount of oxygen required to oxidise the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours.

C. Meymott Tidy, M.B.

ON THE

ESTIMATION OF THE NITROUS COMPOUNDS

IN THE VARIOUS STAGES OF THE

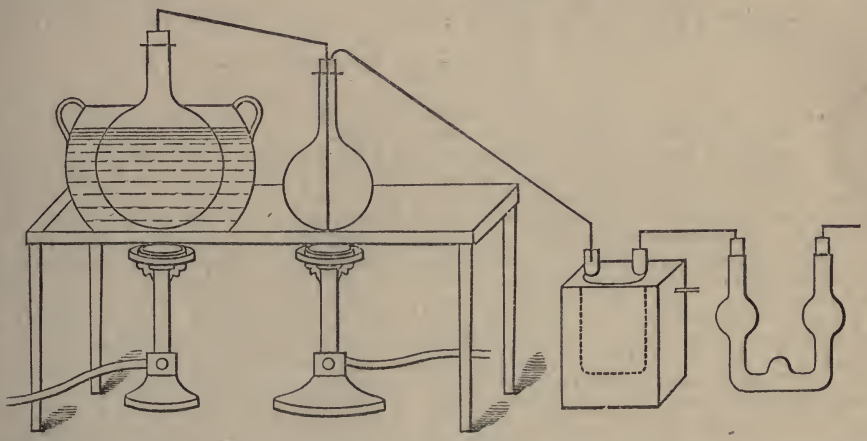
MANUFACTURE OF SULPHURIC ACID.*

By JAMES MACTEAR, F.C.S., F.I.C.

(Continued from p. 17.)

The apparatus used in the operation is thus arranged :—

As the danger of breakage of the flasks is considerable when evaporated nearly to dryness, I use a bath of calcic chloride, which enables a higher heat to be employed, and prevents the breakage of the flasks. (In practice I use copper flasks for the daily testing).



To the large evolution flask which is immersed in the calcic chloride bath is connected a smaller flask, as a wash bottle, and to this again a receiver with a wash tube, as shown in sketch, and the method of conducting an experiment is as follows :—

About 30 grms. iron filings (which should be well boiled with caustic soda to remove grease, or simply roasted), and about 100 grms. granulated zinc, with about 50 grms. caustic soda (free from nitrates), and about 100 c.c. of water, are placed in the flask, with the solution containing the nitrous compounds, say, 200 c.c. of the solution previously mentioned in connection with "total acids" method of estimation, and after connection with the condensing arrangement it is distilled to dryness in the bath of calcic chloride.

The absorbers contain, say, 50 c.c. $\frac{1}{3}$ normal sulphuric acid; and after the distillation is finished, they are washed out and titrated with $\frac{1}{3}$ normal soda; the solution is then boiled with a known excess of standard soda until the ammonia has all been driven off, and again titrated with standard acid.

The following are the results of the special set of experiments referred to in 3rd. (See below.)

From No. 9 downwards all these have been done in the calcic chloride bath, the temperature of which ranged from 240 degrees to 275 degrees F. during the experiments.

Abstracting the figures we have (see next page) :—

It will be at once seen that time is required in all cases for the decomposition, but the operation does not necessitate constant attention; on the contrary, once set agoing, it may be left to itself while other work is carried on, and thus the objections to it as a tedious process are got over.

It will be granted, I think, from these results, that Dr. Lunge was in error in condemning this method in the strong way he did, and concluding "that the process of estimating nitrates by reduction in an alkaline solution cannot be depended upon."

6. For the ordinary purpose of testing nitrous vitriol, there is no doubt that the process he recommends so highly is the most convenient; but it is rendered quite as

SUMMARY OF RESULTS.

Experiment.									
1	used $NaNO_3$,	1 grm.,	alone	Stood for 36 hours on steam bath, then distilled,	100	used,	gave	99·70
2	,, ,,	1 ,,	,, ...	5½ hours distilling	,,	,,	99·66
3	,, ,,	½ ,,	2 grms. Na_2SO_4	6 ,, ,,	,,	,,	99·80
4	,, ,,	½ ,,	alone	5 ,, ,,	,,	,,	99·90
5	,, ,,	½ ,,	,, ...	1 ,, ,,	,,	,,	98·90
6	,, ,,	½ ,,	2 grms. Na_2SO_4	3¼ ,, ,,	,,	,,	99·80
7	,, ,,	½ ,,	alone	5 ,, ,,	,,	,,	100·20
8	,, ,,	½ ,,	5 grms. NaCl + 5 grms. Na_2SO_4	4 ,, ,,	,,	,,	100·10
9	,, ,,	½ ,,	alone	1 ,, ,,	,,	,,	99·98
10	,, ,,	½ ,,	,, ...	1 ,, ,,	,,	,,	99·87
11	,, ,,	½ ,,	5 grms. NaCl + 5 grms. Na_2SO_4	½ ,, ,,	,,	,,	98·50
12	,, ,,	½ ,,	do. do.	¼ ,, ,,	,,	,,	97·60
13	,, ,,	½ ,,	do. do.	1 ,, ,,	,,	,,	99·70
14	,, ,,	1 ,,	do. do.	1 ,, ,,	,,	,,	98·60
15	,, ,,	½ ,,	do. do.	1 ,, ,,	,,	,,	99·40
16	,, ,,	½ ,,	do. do.	1½ ,, ,,	,,	,,	99·60
17	,, ,,	1 ,,	do. do.	2 ,, ,,	,,	,,	99·10

* A Paper read before the Newcastle-upon-Tyne Chemical Society.

1.—With ½ grm $NaNO_3$ *alone*	in 1 hour—No. 9	..	99·98 per cent.
	No. 10	..	99·87 ,,
	Mean		99·92 ,,
2.—With ½ grm. $NaNO_3$ + {5 grms. NaCl, 5 grms. Na_2SO_4}	in ¼ hour—No. 12	..	97·60 ,,
3.—With ½ grm. $NaNO_3$ + {5 grms. NaCl, 5 grms. Na_2SO_4}	in ½ hour—No. 11	..	98·50 ,,
4.—With ½ grm. $NaNO_3$ + {5 grms. NaCl, 5 grms. Na_2SO_4}	in 1 hour—No. 13	..	99·70 ,,
	No. 15	..	99·40 ,,
	Mean		99·55
5.—With 1 grm. $NaNO_3$ + {5 grms. NaCl, 5 grms. Na_2SO_4}	in 1 hour—No. 14	..	98·90 ,,
6.—With ½ grm. $NaNO_3$ + {5 grms. NaCl, 5 grms. Na_2SO_4}	in 1½ hour—No. 16	..	98·60 ,,
7.—With 1 grm. $NaNO_3$ + {5 grms. NaCl, 5 grms. Na_2SO_4}	in 2 hours—No. 17	..	99·10 ,,

liable to error as the other by the presence of nitric acid in the nitrous vitriol from the Gay-Lussac columns. Dr. Lunge no doubt says, "I am inclined to believe that nitrous vitriol really does not contain any nitric acid except perhaps traces in any case;" and previously, "It is not, in the face of it, clear how nitric acid can get into nitrous vitriol, since it cannot very well bodily traverse the chambers without being reduced to lower nitrogen oxides; and since it is not regenerated either from the latter in the presence of sulphuric acid, the oxidation in this case never going beyond N_2O_4, as proved by Winkler himself."

It is quite incomprehensible to me how Dr. Lunge seems to have forgotten the *fact* that N_2O_5 is formed from the decomposition of N_2O_4 in presence of water. His experience of sulphuric acid making must indeed be a happy one who has never seen the disastrous results of the excessive formation of N_2O_5 in this way in the last chambers of a series when excess of steam has produced weak acid and pale colour, which state of things is quite to be looked for if we are anxious to obtain the maximum production.

The decomposition is to some extent dependent on temperature, but may be stated thus:—

$2N_2O_4 + aq = N_2O_5 + N_2O_3$ at low temperatures.
and $3N_2O_4 + aq = 2N_2O_5 + N_2O_2$ at higher ,,

And should we have SO_2 present we have the further decomposition taking place:—

$$N_2O_2 + SO_2 + H_2O = N_2O + H_2SO_4.$$

part at least of the loss of nitrous compounds taking place in this form.

7. It being granted that Dr. Lunge found no N_2O_5 in his specimen of Gay-Lussac acid (which, by the way, is quite abnormal in its character, being of sp. gr. 1·691 = 138° T., and containing in 100 c.c. equal to 4·13 grms. N_2O_3), nothing beyond this bare fact is proved, and no general conclusions can be drawn.

Even in the case of his artificial nitrous acid, where pure potassic nitrate was employed, the difference in the permanganate used in the blank experiment required 1 per cent of the permanganate in excess, an error which is quite absurd where a decided opinion as to the existence or non-existence of even 0·25 per cent N_2O_5 is to be given, and inclines me to believe the statement made by Gay-Lussac that nitrates treated out of contact of air with oil of vitriol evolve nitric oxide gas, while the liquid takes up N_2O_4 and N_2O_5.

Winkler concludes that no N_2O_2 is absorbed by hydrated sulphuric acid, but Gmelin gives authority for the statement that it *is* absorbed in quantity sufficient at least to give a red colour to the vitriol containing ferrous sulphate, this colour being only, however, found occasionally in the nitrous vitriol from Gay-Lussac columns.

In presence of oxygen no doubt the N_2O_2 would oxidise to N_2O_4, which again would possibly split up into N_2O_3, and oxygen, which would escape through the Gay-Lussac column.

I think there is some probability of the view taken of the composition of N_2O_4 by Priestley, Berthollet, Sir H. Davy, and Thomson, in regarding N_2O_4 as really a combination of N_2O_5 and N_2O_2 proving, to some extent, correct; and this is, I think, supported by its peculiar irregularity in vapour-density at various temperatures.

I do not doubt but that as the solubility of nitric oxide (N_2O_2) in hydrated sulphuric acid seems to be comparatively small, a very considerable portion of the loss of nitrogen compounds takes place in this form in many cases, especially where the oxygen in the escaping gases is kept as low as possible.

Professor Hofmann, in the introduction to the third group in the German Catalogue of the Vienna Exhibition of 1873, says, referring to the investigations of Weber, P. W. Hoffmann, and C. A. Winkler, that the former view of the action, in the presence of an insufficient quantity of air, in which a part of the nitric oxide (N_2O_2) was reduced by the SO_2 to the state of nitrous oxide (N_2O), and consequently was lost, has, by these recent researches, been shown to be incorrect, that while in the presence of water in excess this decomposition does take place, for example, with acid of sp. gr. 1·510 (= 102° T.), in the case of the presence of a stronger acid, say of sp. gr. 1·690 (=138° T.), the lowest compound formed with the oxygen is nitric oxide (N_2O_2).

Now, this being so, and the strength of the last chamber of a series being seldom above 100° T., there can be little doubt that some of the loss of nitrogen compounds takes place in this way, as N_2O. A sufficiency of air in the chambers is the best safeguard against this loss.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, January 15, 1880.

Mr. WARREN DE LA RUE, President, in the Chair.

THE following certificates were read for the first time:—A. Lloyd, P. Mathews, G. H. Morris, H. F. Pasley, A. G. Salamon, E. Wilcock, W. H. Wood.

The following papers were read:—

"*On the Effects of the Growth of Plants on the Amount of Matter removed from the Soil by Rain*," by J. H. PREVOST. The soil used was taken from a plot of ground which had been richly manured with stable-manure and ashes in

October, 1878. It was placed in two glazed earthenware pans, the depth of soil being 3 inches. The surface exposed was 17 inches in diameter. The drainage-water was collected, and muslin covers tied over the pan. Each pan contained 4300 grms. soil. In one was sown 4 grms. of white clover seed, the other was left blank. The seed was sown on July 21, and the two pans exposed till October 4. The clover plants had grown up but had not flowered. The drainage from the clover soil contained 48·125 grains per gallon; that from the blank pan amounted to 220 grains per gallon. These residues were analysed. The authors states that it is impossible from the meagre data in hand to draw any definite conclusions, except that the results do not very widely differ from those Dr. Voelcker obtained with the drainage from a wheat-crop; the principal points of interest being that rain removes much more matter from a soil containing no plants than from one which is cropped, and that the proportions in which the salts are removed do not greatly differ. Further researches are promised.

Mr. Warington said that the method of investigation just described was at one time much used in Germany. It was what might have been anticipated, that the loss on a cropped soil would be much less than on an uncropped soil; this had been abundantly proved by the experiments at Rothampstead. Many striking results had been obtained during the past wet season. The best advice to give to farmers was that if they wished to prevent loss of the constituents of the soil they should always keep a crop on it. He had noticed that Dr. Prevost had found phosphoric acid in the drainage. This was exceedingly unusual, as in most cases all was retained. It might be accounted for by the small depth of soil. The soluble organic matter required much investigation.

Mr. Wynter Blyth then described a simple apparatus for the treatment of substances in open dishes by volatile solvents. It consisted of a circular cast-iron pan of suitable size, open at the top. The bottom was not flat, but pushed up in a dimple like the bottom of a wine-bottle. The evaporating dish was placed inside, and covered by a glass bell-jar, the edge of which rested in the circular trough formed by the projecting dimple. Mercury is poured in until the edge of the bell-jar is covered, and thus an air-tight mercury joint formed. To the upper end of the bell-jar is fitted a condenser, which may be vertical and return the condensed liquid to the dish, or horizontal if evaporation is desired. The author had used such an apparatus with great convenience for more than twelve months, the escape of vapour being thus completely prevented. The apparatus was exhibited.

The next paper was read by Mr. W. H. Perkin, "*On Dibrom-anthraquinons.*" Graebe and Liebermann give two processes for the preparation of dibrom-anthraquinon, one by brominating anthraquinon, the other by oxidising tetra-brom-anthracen. These processes yield, however, two different products which are isomeric; they are named by the author α- and β-dibrom-anthraquinon, The α body is prepared by heating bromine with anthraquinon. It crystallises from naphtha in flat needles; it is nearly insoluble in alcohol, and fuses at 245° C. The β isomer is prepared by boiling tetra-brom-anthracen with chromic acid, dissolved in a large excess of glacial acetic acid, for some time. On re-crystallising six or seven times from naphtha, the body was obtained in needles fusing at 275° C., quite different from the crystals of the isomeric α substance. The substance is soluble with difficulty in alcohol. The author then studied the action of caustic alkalies on these two substances, and in both cases alizarin (identified by its dyeing properties, its spectrum, and by analysis) was obtained. The decomposition of the α body furnished, besides alizarin, a colouring matter somewhat resembling alizarin. It dissolves in alkalies with a blue-violet colour, and its alkaline solution is precipitated by lead acetate. It has, however, no dyeing properties. Its absorption-spectrum gives two weak bands. It is not quinizarin nor anthrapurpurin; it may be dioxy-anthraquinon, with the hydroxyls in the same position as the bromine in the dibrom-anthraquinon. A small amount of another colouring seems to be present, dyeing mordants. The author is at present engaged in the study of these substances, the quantity prepared in the present research being too small for a complete investigation. The author then discusses the formation of the same dioxy-anthraquinon from the two isomeric dibrom-anthraquinons. In the case of the β compound, as no secondary matter seems formed, the reaction is—

$$C_6H_4\begin{matrix}CO\\CO\end{matrix}>C_6H_2<\begin{matrix}Br\\Br\end{matrix}+2KHO=$$
$$=C_6H_4\begin{matrix}CO\\CO\end{matrix}>C_6H_2<\begin{matrix}HO\\HO\end{matrix}+2KBr.$$

In the case of the β isomer, probably bromo-monoxy-anthraquinon is first formed. The further action of potash produces brom-alizarin, with the liberation of hydrogen, which attacks the bromine and removes it as hydrobromic acid, and thus alizarin is formed. Probably, too, a certain amount of destruction takes place between the potash and the alizarin, some hydro-anthraquinon being formed. At the end of the paper the author states that he has recently examined Auerbach's original paper on isopurpurin, and concludes that that substance, from the properties given, is a mixture of flavopurpurin and anthrapurpurin, the former substance preponderating. Isopurpurin is not, therefore, identical with anthrapurpurin, as has been stated by the author of the present paper.

The Secretary then read a paper "*On the Melting- and Boiling-Points of certain Inorganic Substances,*" by T. Carnelly and W. Carleton Williams. The authors have determined the melting-points of various substances by the specific heat method (*Chem. Soc. Jour.*, 1876, I., 489). The list includes tellurium, with its chlorides and bromides, cuprous bromide, &c. The boiling-points were determined by the method described in the *Chem. Soc. Jour.*, 1878, Trans. 281. The melting-points of silver and copper have been recently re-determined by Violle, and, in consequence, some corrections have been necessitated in the last paper of the authors (*Chem. Soc. Jour.*, 1879). The authors point out that in the mercuric compounds the melting-point sinks and the boiling-point rises with an increased molecular weight: the reverse is the case with cuprous compounds. Thus—

		Chlorides.	Bromides.	Iodides.
Mercuric	Melting-point ..	287	244	241
	Boiling-point ..	303	319	349
Cuprous	Melting-point ..	434	504	601
	Boiling-point ..	954	861	760

Mr. Warington then contributed some Notes on some Practical Points connected with his Laboratory Experience. The first point considered was the modification proposed by Dr. Frankland some time since as a substitute for the steel blocks which form the air-tight connectors between the laboratory and the measuring-tubes in the gas apparatus. It will be remembered that Dr. Frankland causes the measuring-tube to end in an upright funnel in which fits roughly a conical stopper which terminates the laboratory tube. The joint was made tight by a piece of sheet india-rubber tied on the lower end of this conical stopper, the india-rubber being turned back, applied to the sides of the funnel, and the joint covered with mercury. This modification the author has found extremely convenient. One difficulty was the constant wearing out of the india-rubber: this was traced to its rubbing up and down as it was not absolutely fixed on the stopper. By tying the india-rubber above as well as below the stopper this has been obviated, and the rubber lasts many months instead of a week. The author strongly recommends the coating of laboratory benches, mercury troughs, &c., with paraffin. The wood is made quite hot by a Bunsen flame or in an oven, and the paraffin rubbed in. Thus the wood is completely protected from the action of acids. In the

determination of nitric acid by Frankland's process the author has observed that the action is often incomplete when the attack on the mercury is feeble: by adding a drop of dilute hydrochloric acid the reaction is always vigorous and the results good. Diphenylamin solution in strong sulphuric acid forms a magnificent blue colouration in the presence of a trace of nitrate. The author has thus detected 1-10,000th of a milligrm. of nitrogen as nitric acid; the absence of other oxidising agents must be secured.

The Society then adjourned to February 5.

SOCIETY OF PUBLIC ANALYSTS.

The annual meeting of this Society was held on Wednesday evening, at Burlington House, the President, Dr. Muter, in the Chair.

A ballot took place for the election of officers, when the following were elected:—Dr. Muter, President; Dr. Dupré, Dr. Tripe, and A. Wynter Blyth, Vice-Presidents; C. W. Heaton, Treasurer; C. Heisch and G. W. Wigner, Hon. Secretaries; and Messrs. Carter-Bell, Campbell Brown, C. A. Cameron, Bernard Dyer, Otto Hehner, W. Morgan, and W. Wallace, in place of the outgoing Members of Council.

Professor C. R. C. Tichborne was also elected a member of the Society, and Mr. Bruce Warren was proposed for election.

After the President had delivered his Annual Address, Mr. Wigner read a paper by himself and Prof. Church, "*On Two Ancient Samples of Butter*," of which the following is an abstract:—

The first was a sample of Irish bog butter, and its probable age was judged to be about one thousand years. The sample contains nearly 4 per cent of curd, which consisted partly of vegetable matter derived from the bog, but contained quite enough animal matter to prove that the butter had been originally made from animal milk, and was not a mere artificial fat. Its fatty character had, however, been entirely changed, and the glycerides of which the fat had originally consisted had been decomposed so as to leave simply a mixture of the fatty acids, which constituted the acid portion of animal fats. The butter had in fact become changed into a substance closely resembling in character and composition the substance of which good composite candles are composed. The result is singular, as showing that length of time combined with exposure to moisture will effect the decomposition which the manufacturer of stearine has to effect by the agency of heat and acids. The other and older sample of butter had been taken from an alabaster vase in an Egyptian tomb; it had evidently been melted and poured into the vase, and carefully sealed over. This sample was probably about 2500 years old, but the preservation had been so perfect that it was only slightly rancid, and had fully retained the chemical properties of genuine butter, the fats not having been decomposed to any sensible extent. This sample possessed a decided taste and smell of butter, while the sample from the bog was cheesy rather than buttery in smell.

The following papers were also read:—

"*On the Composition of Unfermented Wines of Commerce*," by Mr. Carter Bell.

"*On the Estimation of Fat in Milk*," by Mr. W. M. Hamlet.

The members and several friends afterwards dined together at the Café Royal.

Presence of the Diamond in an Ophitic Rock from South Africa.—F. Fouqué and A. Michel Lévy.—A single specimen of this rock presents the diamond along with opal.—*Comptes Rendus.*

NOTICES OF BOOKS.

Year-Book of Pharmacy, from July 1st, 1878, to June 30, 1879. London: J. and A. Churchill.

This volume consists of two distinct portions. We have, first, a collection of abstracts of papers taken from British and Foreign Journals and from the *Transactions* of learned societies. This section is subdivided into the heads Pharmaceutical Chemistry, Materia Medica, Pharmacy, and Notes and Formulæ, and contains a valuable assortment of matter, much of which, however, the readers of the book will doubtless have seen elsewhere. We can scarcely give our approbation to the system of classification followed by the compilers. Many of the papers ranking under the head "Pharmaceutical Chemistry" seem to us to belong rather to chapters on analytical, general, and industrial chemistry. What, for instance, is the pharmaceutical bearing of papers on the colouring matters of santal and calliatura wood, and of *Lithospermum erythrorhizon?* Analytical processes—and especially methods for the detection and quantitative determination of impurities or sophistications in articles of food, drugs, and chemicals—appear to figure somewhat indiscriminately under the heads "Pharmaceutical Chemistry" and "Pharmacy." We submit that a more careful arrangement of matter would increase the value of the book by rendering it easier for the reader to find what he is in search of.

The second portion of the book—the account of the British Pharmaceutical Conference, which met at Sheffield simultaneously with the British Association—contains matter of permanent interest, which it might not be very easy to find elsewhere. The opening speech of the President, Mr. Schacht, touching principally on the position of the pharmacist in society, and of the relations between pharmacy and what he rightly calls the other branches of the medical art, are most important. We feel deeply obliged to him for using, consistently with the practice of all other European nations, the definite and appropriate term "pharmacist" instead of the vague and misleading word "chemist." We call the latter vague and misleading because, logically speaking, it belongs to all men engaged in the study of chemistry, or in the practice of any of its applications. His remark that in modern medical schools chemistry is an "off-subject," and is very generally done "any-how or no-how" is but too true, as we have long known and repeatedly lamented.

We cannot help regretting that neither the President nor any of the members expressed an opinion on a modern practice injurious to the pharmaceutical profession, and liable to result in serious danger to the public. We refer to the sale of so-called patent medicines—many of which contain poisonous ingredients—by drapers, grocers, and other totally unqualified persons. In fact the whole question of patent medicines calls for the re-consideration of the Legislature.

Dr. Hamberg's paper on the capacity of different organs to absorb and retain arsenic in cases of chronic poisoning excited a small display of anti-vivisectionist feeling, but must be pronounced exceedingly valuable. We fail to see how the results could possibly have been attained by any other method than that pursued by the author.

We are somewhat surprised to learn that Panama bark (*Quillaria saponaria*) figures in the *Materia Medica*. Having once thoughtlessly chewed a small fragment whilst engaged with some experiments on its uses in dyeing, we were greatly annoyed by its persistent irritating action upon the throat.

The papers by Mr. A. H. Allen on "Petroleum Spirit,"—so-called "benzoline," and by Mr. E. Davies, on the estimation of water in iodine, are of general interest to professional chemists.

CORRESPONDENCE.

BLUE FLAME IN COAL FIRES.

To the Editor of the Chemical News.

SIR,—I think Col. Ross has mistaken the question that was at issue, in his letter with the above heading (CHEMICAL NEWS, vol. xli., p. 22). I am not aware that the blue flame usually observed in coal fires, and which is due to carbon monoxide, has ever been attributed to $CuCl_2$ or sulphur. It was the blue flame produced by *common salt* that formed the subject of debate (as early as 1876); and in a communication to the CHEMICAL NEWS, vol. xxxix., p. 141, and also in *Nature*, March 27, 1879, I gave some reasons for attributing it to HCl, which supposition I afterwards confirmed (*Nature*, May 1, 1879).

Col. Ross's theory is ingenious, but unfortunately for it the question arises—Where is the coal-gas to come from when all the bituminous matter has been burned away and nothing but carbon left?

That the burning CO is not seen till the luminous flames have disappeared seems chiefly due to the small quantity of light which it emits. It is a popular saying that the fire "burns blue" in frosty weather, and I have frequently noticed that the saying is more or less true. I endeavour to explain it by the fact that larger fires than usual are made in cold weather, and that a large body of red-hot cinders is most favourable for the production of CO.—I am, &c.,

A. PERCY SMITH.

Temple Observatory, Rugby,
January 10, 1880.

THE TESTING OF VITRIOL-CHAMBER EXITS.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS (vol. xli., p. 16) you publish a paper by Mr. J. Mactear on the testing of vitriol-chamber exits. Now, in the beginning of May last year, I found myself called upon to test a vitriol-chamber exit without having any standard solutions at hand, and I then hit upon a method which I have used ever since, and as I have found it both very convenient and accurate, a description of it will perhaps be of interest in connection with Mr. Mactear's paper.

I had previously been accustomed to use the method which Mr. Mactear aptly calls that of "total acids," which, however, is open to the objections that the estimation of the S compounds is made by the always troublesome processes of precipitation, filtration, and weighing; that any error in estimating the SO_3 gives rise to a greatly more serious one in the reckoning of the N compounds; and that as it takes no account of HCl the accuracy of the N compounds determination is still further impaired. My method gets rid of these and other objections, and is as follows:—

I absorb in a solution of carbonate of soda, with addition of peroxide of hydrogen, as recommended by Mr. G. E. Davis (CHEMICAL NEWS, vol. xxxix., p. 221), after taking the precautions there mentioned by him for ascertaining the strength and purity of the H_2O_2. When finished, the absorbing tubes are emptied into a basin, and the solution evaporated to dryness to ensure complete expulsion of free O. I then add standard H_2SO_4 to neutralisation without previous addition of water, in order to keep the bulk of liquid as small as possible, using litmus-paper instead of solution to avoid introducing organic matter. The point of neutrality should not be passed for fear of loss of vapour of HNO_3 on boiling to expel CO_2.

The solution, which should not amount to more than 3 to 5 c.c., is then placed in the mercury tube, and the HNO_3 estimated according to Crum's method. For this latter purpose the same apparatus is used as is employed now pretty generally for the estimation of N_2O_3 in nitrous vitriol (*vide* Mr. G. E. Davis, CHEMICAL NEWS, vol. xxxvii., p. 45, and Dr. Lunge, vol. xxxviii., p. 19.

It is best to place the solution in the tube without cooling completely. The addition of the O.V. raises the temperature still further, so that the reaction generally commences at once—otherwise it may hang fire for a considerable time, in which case warming the tube over a flame will start the reaction, which then finishes in a minute or two, and the NO is read off on cooling.

By following the foregoing course we get the N compounds estimated directly; the S compounds by difference; any HCl reckoned with the S; and the whole done very expeditiously and neatly. Of course, by dividing the solution we can estimate the three each directly, the SO_3 with barium and the HCl with silver.

I usually take for absorbing 50 c.c. of Na_2CO_3 solution containing 5 grs. Na_2CO_3, add 10 c.c. H_2O_2, and aspirate 3 to 4 cubic feet per twenty-four hours.

For calculating 1 c.c. NO = 0·0365 gr. Na_2CO_3.
= 0·0262 gr. N_2O_3.
= 0·0585 gr. $NaNO_3$.

Mr. Warington, in a paper read before the Chemical Society, May 1, 1879, has shown that to vitiate Crum's test HCl must be in very great excess, but that organic matter may be objectionable.—I am, &c.,

T. E. VASEY.

Church Street Chemical Works,
Hunslet, Leeds.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 26, December 29, 1879.

On Copper Hydride: a Reply to M. Wurtz.—M. Berthelot.—The author points out that M. Wurtz, though admitting that the so-called hydride contains the elements of copper phosphate, hesitates to accept the necessary conclusion. To obtain the hydride of copper in a state of purity, and to show that the oxygen and the phosphorus are not inherent in the constitution of the compound, are tasks incumbent upon M. Wurtz and not upon the author.

Heat of Formation of Gaseous Chloral Hydrate: a Reply to M. Wurtz.—M. Berthelot.—The author announces that the temperature of the double glass case in which M. Wurtz mixes his gaseous masses is not constantly the same, before each experiment, as that of the bath surrounding this double case. The temperature of the water-bath employed, without proper enclosures, being brought, as he has done, to a point other than that of the ebullition of water, is not constant. The temperature realised by the mixture of the two gaseous masses is neither constant nor equal to the mean temperature. The variations are such as to exceed the slight rise of temperature which might result under these conditions from the combination of the vapour of water with that of chloral. The errors are still greater on operating as M. Wurtz has done under pressures less than that of the atmosphere, since the masses brought into action are thus diminished at the same time as the operations relating to the exact mixture, and the escape of the gases are rendered more complicated. These masses, if reduced to water, cannot surpass a few grammes in the experiments of M. Wurtz. Even the very mixture of the gases is necessarily imperfect in an apparatus arranged like that of M. Wurtz, a circumstance which must reduce the elevation of temperature observable.

Oxidation of Alcohol by the Ammoniacal Binoxide of Copper.—A. Letellier.—The author heated to 180° in

a sealed tube a mixture of alcohol and of binoxide of copper dissolved in ammonia. The liquid became colourless and the alcohol was converted into acetic acid. All the alcohols, glycerin, benzol, and oil of turpentine, if heated with ammoniacal cupric oxide, decolourise the liquid. The products formed have not yet been examined.

A New Electric Burner.—M. Perruche.—The burner itself, or candle, is composed of three cokes, of which two are cylinders, whilst the third has a square section. Two of them are in close contact during the combustions and form only a single electrode. The third is placed upon a line bisecting the angle formed by the other two, and forms the other electrode. The regulating apparatus is described at some length.

A New Phoneidoscopic Process by Means of Coloured Rings.—A. Guebhard.—In a recent communication (Dec. 8, 1879) the author described the production of coloured rings by the condensation of watery vapour on the freshly cleansed surface of impure mercury. He finds that these bands of colour may be applied to the study of the internal movements of masses, and of the vibration of masses, being much more sensitive than pulverulent bodies. Vocal currents, in particular, impress upon the mercury characteristic diagrams, some of which are figured.

Action of Potassium Permanganate upon Potassium Cyanide.—E. Baudrimont.—If standard solutions of these bodies are allowed to react upon each other, the author finds: That the decolouration of the permanganate has a necessary limit; this decolouration is facilitated by an elevation of temperature and the concentration of liquids; its limit is attained when 2 equivs. KCy are in contact with 5 equivs. of permanganate. The action is ess rapid when the liquids are acidified with sulphuric acid. The products formed by the mutual reaction of the salts differ in their proportions if not in their nature. Those whose presence has been ascertained are urea, the carbonic, nitrous, nitric, oxalic, and formic acids, and ammonia, due to the decomposition of the urea. The quantity of urea increases the more the mixture is acidified with sulphuric acid.

Action of the Hydracids upon Isopren; Reproduction of Caoutchouc.—G. Bouchardat.—Isopren in contact with the hydracids behaves like valerylen, and, like the latter, fixes one or two molecules of acid, forming identical or isomeric compounds, but closely allied in their properties. Isopren, however, yields with the acids an elastic polymer, possessing most of the attributes of caoutchouc. It is insoluble in alcohol, swells up in ether, and in the sulphide of carbon, in which it dissolves in the same manner as natural caoutchouc. If submitted to dry distillation it yields the same volatile carbides as caoutchouc.

Journal des Savants. November, 1879.

Studies on the Physical Functions of Leaves.—E. Chevreul.—Among the conclusions which the author regards as established are:—That the transpiration by both surfaces of the leaf is greater in the sunshine than in the shade. With the exception of the oleander and the maize plant, which exhibit in this respect an anomaly, it appears that in the numerous species experimented upon if the transpiration from the upper side of the leaf is represented by unity, that of the reverse equals 4·3. In the shade, however, the proportions are as 1 : 2·4. The leaves of the chestnut, of maize, and of the periwinkle, transpire equally on both surfaces. It has been already demonstrated that plants absorb solutions of the salts necessary for their growth, not merely by the leaves, but even by the petals of their flowers.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin, No. 15, 1879.

Partial Synthesis of Milk-sugar, and Contribution to the Synthesis of Cane-sugar.—E. Demole.—Setting out with the idea that the glucose molecule of cane- and of milk-sugar are different, the author endeavoured to take a further step in the synthesis of these sugars by combining, on the one hand, levulose with dextro-glucose, and, on the other, galactose with lacto-glucose. In the second case he has succeeded. Milk-sugar was first resolved into two isomeric bodies, galactose and lacto-glucose, by the action of dilute acids. The product of this reaction, after removal of the acid, was evaporated and carefully dried, and was found to possess all the properties of a mixture of equal mols. galactose and lacto-glucose. It was treated with three parts of acetic anhydride in an apparatus provided with a cohobator, and heated to the boiling-point until totally dissolved. On subsequent treatment a body was obtained possessing all the properties of octacetyl-lactose.

A Preliminary Communication.—J. Moritz.—The author has found that sulphur dusted over vines as a remedy for *Oidium Tuckeri*, is converted into sulphurous acid.

On Carbohydrates.—A. P. N. Franchimont.—The author has investigated animal cellulose (tunicin), glucose, and vegetable cellulose. The first-mentioned substance was converted into glucose exactly as is vegetable cellulose. It is still, however, possible that the two bodies are not identical, and that their difference, if it exists, may depend upon polymerism.

Meta-isatinic Acid (Meta-amido-phenyl-glyoxylic Acid).—L. Claisen and C. M. Thompson.—The author describes the formation of this acid and the properties of certain of its derivatives.

On H. O. Pawel's Communication concerning Roussin's Salt.—W. Demel.—The author points out that H. Pawel has criticised him without having read his memoir in full.

Reply to the Remarks of H. H. Salkowski.—W. Demel.—An apology for an oversight in a question of priority relating to the arseniates of zinc and cadmium.

On Roussin's Salt.—O. Pawel.—The author maintains that the compound described as nitric oxide-iron-sulphide is simply a mixture of several salts with sulphur as an impurity, and always containing an alkali metal. He shows at some length the true nature of Roussin's salts.

Decomposition of Mesoxalic Acid by Hydrogen Sulphide.—C. Böttinger.—The mesoxalic acid is first resolved into carbonic and glyoxylic acids, the latter of which is then transformed into thioglycolic acid. The oxalic acid found among the products is probably due to a secondary reaction.

Mendelejeff's Periodic Law and the Magnetic Properties of the Elements.—T. Carnelly.—The author shows that those elements which belong to the even series in Mendelejeff's classification are always paramagnetic, whilst those of the odd series are as constantly diamagnetic. He concludes that the investigation of the magnetic properties of newly-discovered or imperfectly-known elements is of importance for determining their place in a general classification. The uneven elements of a group seem to become more and more diamagnetic as their atomic weights increase. In the eighth group the paramagnetism seems to decrease with the increase of the atomic weight.

Di- and Tri-Derivatives of Naphthalin.—Raphael Meldola.—An account of α-β-di-brom naphthyl-amin, α-β-di-brom-naphthalin, and of the constitution of α-sulpho-brom-naphthalic acid.

A Correction.—C. Councler.—This note relates to the constitution of fluoboric ethylen.

THE CHEMICAL NEWS.

VOL. XLI. No. 1053.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF

(Continued from page 40.)

THE three elements which are found in cerite, viz., cerium, lanthanum, and didymium, have very nearly the same equivalents (about 45)* and similar properties; it is therefore difficult to determine the atomic weights of these elements. Involuntarily we think that they are analogous to those of the iron group, particularly because cerium has some of the properties of manganese. However, we can only admit the analogy if we have simply a superficial knowledge of the metals from cerite. If we admit the formula RO for their ordinary oxides, their atomic weights will be approximatively 92, which will not agree with the eighth group. Even if we give their oxides the formula R_2O_3, these elements will not enter the eighth group, because their atomic weights would then be about 138; and the reason of this exclusion is not only that the elements of group VIII., series 8, should have an atomic weight averaging between Pd and Pl (about—

$$150=\frac{105+195}{2}),$$

but it is above all because the known properties of these elements do not correspond with the properties of the missing members of the eighth group. The metals of cerite are more difficultly reducible—they only give a small number of oxides; the ordinary oxides possess very strongly basic properties; as far as we know they do not give such characteristical ammonic and cyanic compounds; in a word, they are not the atomanalogues of the metals of the eighth group (see Chap. I.).

Let us give still one more proof:—

According to Wœhler, the density of cerium is 5·5. If we accept CeO as the formula of the ordinary suboxide, Ce=92, the atomic volume=17: but if we admit that the suboxide is represented by Ce_2O_3, then Ce=138, and the atomic volume = 25. These two volumes do not correspond with the members of the eighth group, which have much smaller atomic volumes. If we take RO as the formula of the ordinary oxides of the metals of cerite, we cannot place them either in the second or third group. It only remains for us to try if other forms of oxides are applicable, as we did before when determining the atomic weight of indium. For this purpose we will firstly consider cerium only, then afterwards we will examine lanthanum and didymium, superficially and simultaneously, because cerium has been better studied than the other two metals, and it gives at least two basic forms of oxidation. This circumstance facilitates the determination of the atomic weight very much.

If we admit, according to the general opinion, that the atomic weight of cerium is 92, the ordinary strongly basic oxide, which is the lower or suboxide, is represented by CeO, and the highest oxide, which give salts with the acids, is $Ce_3O_4=CeO,Ce_2O_3$. By attributing this composition to the highest oxide, we still admit an oxide of the formula Ce_2O_3,† although this oxide has never yet been obtained and none of its salts are known. Rammelsberg, Hermann, Holzmann, Zschiesche, &c., have obtained not only simple salts of the oxide Ce_3X—example, the yellow salt $Ce_3(SO_4)_4,8H_2O$—but also different salts of suboxide of cerium. Their composition is expressed by the formula $Ce_3X_8,nCeX_2$; however, we do not know of any salts which contain more acid residues than what corresponds to the form Ce_3X_8. Therefore we should only admit there to be two actual forms of oxidation of Ce; these are—

CeO and Ce_3O_4 (Ce=92).

Its tenacity for oxygen is in the relation 3:4; therefore I think it would be more natural to give the formula Ce_2O_3 to the first of these oxides, and the formula Ce_2O_4 or CeO_2 to the second.* This is as good as giving Ce the atomic weight 138 (46×3), and giving it the corresponding place in the fourth group; this also agrees with the new formula of the highest oxide. The element Ce takes its place in the eighth series; it has as atomanalogues Ti, Zr, and Th in the fourth group, and Cs = 135 and Ba = 137† in the eighth series. The transition from CeO_2 to Ce_2O_3 corresponds to the transition from TiO_2 to Ti_2O_3, and, better still, from PbO_2 to Pb_2O_3 and to PbO.‡ The higher oxide of cerium exhibits the properties of a peroxide, and its reactions resemble those of PbO_2, Tl_2O_3, and TeO_3.

We can explain the feeble basic properties of CeO_2 by the fact that it is placed in the fourth group after TeO_2, whose basic properties are very uncertain, and also after ZrO_2, whose basic character is very doubtful. In the case of ThO_2, which comes after CeO_2, these properties are more doubtful still, its atomic weight being relatively higher than that of Ce. The strongly basic properties of Ce_2O_3 find their explanation in this circumstance, that PbO_2, Tl_2O_3, TiO_2, and CuO also give more basic bodies when reduced. The fundamental properties of the oxides of cerium are explained by reason of the position of Ce in relation to the system: in an even series after Cs and Ba, whose properties are strongly basic. To the atomanalogy of Ce with Ti, Zr, Th, corresponds their association in a great number of minerals—rare, it is true.

To show more completely that the place given to cerium in the system, if we adopt Ce=138 or 140, agrees in reality with its properties, I am going to show, comparatively, the known volumes and densities of the element and of the oxide. If, in an even series, we start from the first group, we notice an increase of density, such as the density of Rb=1·5, that of Sr=2·5, that of Zr=4·2. The density of Cs is unknown; however, according to conclusions which I shall communicate later on, it ought to be about 2·5; the density of Ba=3·6; of Ce=5·5. The volume of Ti=9·3, of Zr=22, of Ce=25, of Th=30; consequently the volume increases here, as in the other groups, according as the atomic weight increases. The volume of TiO_2=20, of ZrO_2=22, of CeO_2=24, of ThO_2=29, that is to say, that in this series as in the parallel one, viz., SiO_2=22. SnO_2=22, PbO_2=26, the volumes of the higher oxides increase regularly, although only slightly, as the atomic weight becomes greater.

If, as is thus shown, the new position of cerium in the system corresponds to its properties, both chemical and physical, there are two motives why we should search for a new means of confirming the exactitude of the hypothesis given above, relative to a modification of the atomic weight of cerium. Firstly, CeO_2 is easily reduced to the

* According to the determinations of Haeringer, Marignac, Hermann, Bunsen, and Rammelsberg, the equivalent of Ce=46; according to Wolff it is 45·66. For lanthanum, Rammelsberg found the figure 44·4; Zschiesche found 45·1; Holzmann found 46·3; Czudnowicz 46·8; Marignac from 46 to 47; and Erk 45·1. For didymium Zschiesche found from 46·6 to 48·1; Hermann, 46·7; Marignac, 48; and Erk, from 47·4 to 47 8.

† Popp and Hermann have mentioned other oxides, such as Ce_3O_5 and CeO_3, but these assertions have not been confirmed by any other chemists, and [illegible]

* Up to the present I do not see how it is possible to give the oxides the formulæ CeO_3 and CeO_4, thus making Ce=276.

† There is good reason for the supposition that, in future experiments, the atomic weight of Ce will be found to be much greater, for at present it is very near that of Ba, and we can better afford to admit errors in the number found for Ce than in the carefully determined atomic weight of Ba. Slight impurities, such as La and Di, the difficulties of analysis, to which Marignac has called attention, as well as the difficulty in obtaining the compounds of suboxide of cerium free from compounds of oxide of cerium, are quite sufficient to account for the low atomic weight admitted by the periodic law. This is the reason I have provisionally given cerium the atomic weight 140.

‡ We can imagine that the ordinary oxides of Zr and Th will give basic suboxides Th_2O_3 and Zr_2O_3. As far as the latter is concerned I purpose doing the necessary experiments, for I have recently received a considerable quantity of zircons from the Ilmen mountains (Siberia.)

state of Ce_2O_3. The highest atomic analogue of cerium, namely, Th, has not, as far as we know, a similar property,* although, from what has been previously said (see Chap. I.), the highest members of a group are the most easily reducible. Secondly, there are other elements which possess the same equivalent as Ce (46 in the suboxide, 34·5 in the oxide), or a very similar one (such as La and Di as suboxides, and Yt as oxide), which ought to be able to occupy a different position in the system. Therefore it seems to me that a more profound knowledge of the compounds of cerium is necessary before we can be certain of the exactitude of the modified atomic weight. Up to the present I have only made one determination of the specific heat of metallic cerium.† This metal was obtained from H. Schuchardt, of Goerlitz. The number 0·5—found from small half-melted lumps which had been dried in hydrogen—shows that the specific heat of cerium is less than that of tin, and equal to that of metallic barium found at the same time. The number found coincides better with the modified atomic weight than with the old one, for $0·05 \times 138 = 6·9$, whilst $0·05 \times 96 = 4·8$. However, it is desirable to repeat this experiment.

(To be continued.)

REPORT TO THE LOCAL GOVERNMENT BOARD AS TO TREATMENT OF SEWAGE.

By Dr. ANGUS SMITH, F.R.S.

As requested, I have the honour to submit a careful examination of five effluents, the results of processes for the purification of sewage water by different methods.

1. From Aldershot, where irrigation alone is used.
2. From Coventry, where precipitation by alum and iron is used first and irrigation afterwards.
3. From Birmingham where precipitation by lime is employed.
4. From Burnley where also lime is employed.
5. From Aylesbury where the A B C process is used, a precipitant of alum being employed, also of clay.

I shall extract from the larger tables some of the more important points; but I wish it to be observed that in this report I refer to quality of effluents only, and not at all to the ultimate value of processes.

FREE AMMONIA, A.

	Ammonia abstracted.		Ammonia remaining.	
	Parts per 100,000.	Per cent of Total.	Parts per 100,000.	Per cent of Total.
Aldershot, *b* ..	11·755	97·96	0·245	2·04
Coventry	2·06	79·8	0·520	20·2
Aldershot, *a* ..	2·913	80·10	0·747	19·9
Aylesbury ..	2·980	74·5	1·020	25·5
Birmingham, *a*	1·425	52·9	1·275	47·1
Burnley	0·120 added	8·3 added	1·330	91·7
Birmingham, *b*	0·520	18·8	3·220	118·8

NOTE.—Aldershot (*a*) specimen collected in wet weather; (*b*) in dry weather; Birmingham (*a*) after lime precipitation and irrigation; (*b*) after lime alone.

Free includes saline ammonia. Its existence is of no disadvantage so far as the effect on the atmosphere is concerned, but its absorption by the soil is important as manure. Its amount indicates decomposition. So far as free ammonia is concerned, the first on the list is Aldershot during dry weather, specimen *b*; Coventry stands second. There two processes are used, both precipitation (with alum, iron, and lime) and irrigation. The next is Aylesbury. The lime processes are certainly behind.

ALBUMINOID AMMONIA, B.

	Ammonia abstracted.		Ammonia remaining.	
	Parts per 100,000.	Per cent of Total.	Parts per 100,000.	Per cent of Total.
Aldershot, *b* ..	5·195	98·95	0·0550	1·05
Coventry	1·639	96·40	0·061	3·60
Aylesbury ..	0·59	89·40	0·070	10·60
Aldershot, *a* ..	1·543	88·2	0·207	11·8
Birmingham, *a*	0·840	80·0	0·210	20·0
Burnley	0·895	74·6	0·305	25·4
Birmingham, *b*	0·390	37·1	0·660	62·9

On this table Aldershot on a dry day stands best, but not on a wet day. Coventry with its double system is next best. Aylesbury with precipitation alone is almost the same as Coventry with its double purification.

Perhaps this expression "on a dry day" is not quite fair, it is meant to show that in a case of an overflow there may be little or no purification, but there is generally some unless the flood be great.

RESIDUAL AMMONIA, C.

	Ammonia abstracted.		Ammonia remaining.	
	Parts per 100,000.	Per cent of Total.	Parts per 100,000.	Per cent of Total.
Aldershot, *b* ..	11·36	100·0	0·00	0·00
Coventry ..	5·081	99·8	0·009	0·2
Aylesbury ..	4·269	88·0	0·581	12·0
Aldershot, *a* ..	3·177	83·0	0·636	17·0
Birmingham, *a*	3·351	61·4	2·109	38·6
Burnley	1·200	29·65	2·503	70·35
Birmingham, *b*	1·530	28·0	3·930	72·0

Aldershot (dry) is again the best; Coventry next; Aylesbury third.

The two chief ammonias in a sanitary point of view are the albuminoid and residual. They are therefore added here.

TABLE D.—TOTAL ORGANIC AMMONIA, *i.e.*, Albuminoid and Residual; both Ammonias may be called "possible."

	Ammonia abstracted.		Ammonia remaining.	
	Parts per 100,000.	Per cent of Total.	Parts per 100,000.	Per cent of Total.
Aldershot, *b* ..	16·555	99·65	0·055	0·35
Coventry	6·720	98·97	0·070	1·03
Aylesbury ..	4·859	88·20	0·651	11·80
Aldershot, *a* ..	4·720	84·84	0·843	15·16
Birmingham, *a*	4·191	64·40	2·319	35·60
Burnley	2·095	42·73	2·808	57 27
Birmingham, *b*	1·920	29·60	4·590	70·40

TABLE E.—TOTAL AMMONIA.

Aldershot, *b* ..	28·31	98·9	0·300	1·1
Coventry	8·78	93·6	0·590	6·4
Aldershot, *a* ..	7·633	82·7	1·590	17·3
Aylesbury ..	7·839	82·4	1·671	17·6
Birmingham, *a*	5 616	60·9	3·594	39·1
Burnley	2·215	34·9	4·138	65·1
Birmingham, *b*	1·400	15·2	7·810	84·8

It is seen here that the lowest effluent for total ammonia is from the irrigation farm in dry weather. Coventry next. Aldershot (wet) and Aylesbury stand third nearly the same.

NITRIC ACID.

	Sewage.	Effluent
Aldershot, *b*		9·23
Aylesbury	none	3·19
Aldershot, *a*	traces	2·79
Birmingham, *b*	none	2·13
Coventry	„	1·22
Burnley		1·20
Birmingham, *a*	„	1·19

* We can hardly believe that this phenomenon could have escaped detection if thorium had the property to any great extent, for it has been studied by Berzélius, Chydenius, and Delafontaine, and their results agree. Unhappily, thorium cannot be studied much on account of its rarity.

† *Bulletin de l'Académie des Sciences de St. Pétersbourg*, 1870, p. 445.

Analyses of Specimens of Waters from Sewage Works, Expressed in Parts per 100,000.

Samples from Burnley, collected June 16, 1879. (See Report by Dr. R. Angus Smith.)

	Organic Carbon.	Free Ammonia.	Albuminoid Ammonia.	Residual Ammonia.	Total Ammonia.	Nitric Acid.	Sulphuric Acid.	Chlorine.	Mineral Solids.	Volatile Solids.	Total Solids.	Alkalinity as SO_3.	Hardness Before Boiling.	Hardness After Boiling.
Stream above sewage works.	0·476	0·025	0·024	0·075	0·124	0·50	3·26	1·28	17·0	3·0	20·0	7·50	10·81	7·78
Do. below ditto.. ..	0·987	0·236	0·070	0·219	0·525	0·56	4·12	1·90	18·5	6·5	25·0	9·00	12·64	8·22
Crude sewage	20·33	1·45	1·20	3·703	6·353	—	6·35	5·12	49·0	148·0	197·0	13·00	—	—
Effluent from sewage works.	3·737	1·33	0·305	2·503	4·138	1·20	7·38	5·06	40·0	14·0	54·0	13·00	20·92	17·16
Samples from Birmingham, collected June 23, 1879.														
Crude sewage	20·44	2·70	1·05	5·46	9·21	none	25·23	24·16	102·0	75·0	177·0	13·83	45·0	44·0
Effluent from settling tanks.	4·09	3·22	0·66	3·93	7·81	2·13	22·65	15·78	74·0	26·5	100·5	11·32	39·0	38·4
Effluent after irrigation	2·303	1·275	0·21	2·109	3·594	1·19	18·19	11·46	88·5	24·0	112·5	37·77	66·8	29·22
Samples from Coventry, collected June 24, 1879.														
Crude sewage	11·33	2·58	1·700	5·09	9·370	none	11·33	6·85	59·0	31 0	90·0	25·35	32·80	9·85
Effluent from settling tanks (filtered).	1·418	2·40	0·245	0·511	3·156	none	7·21	6·30	55·0	16·0	71·0	22·34	37·15	15·62
Effluent after irrigation (drain out of order).	0·587	2·12	0·205	0·895	3·220	1·22	13·21	5·73	58·0	19·0	77·0	12·62	35·45	17·65
Sample from Coventry, collected July 10, 1879.														
Effluent after irrigation	0 618	0·52	0·061	0·009	0·590	1·62	13·39	4·99	58·5	12·0	70·5	21·0	40·70	19·72
Samples from Aldershot, collected July 1, 1879 (wet weather).														
Crude sewage	16·90	3·660	1·750	3·813	9·223	traces	2·04	4·38	41·0	32·0	73·0	9·40	6·71	3·38
Effluent "A" from sewage farm.	—	0·920	0·276	0·803	1·999	2·69	5·14	4·54	24·0	16·0	28·0	2·50	6·57	6·29
Effluent "B" from sewage farm.	2·282	0·880	0·200	0·788	1·868	1·59	1·89	3·14	15·0	11·0	26·0	1·90	5·00	4·57
Effluent "C" from sewage farm.	2·240	0·440	0·144	6·318	0·902	4·08	2·40	3·20	20·0	14·5	34·5	0·70	7·86	6·86
Collected September 13, 1879 (dry weather).														
River Blackwater ..	0·536	0·0108	0·03	0·0542	0·095	1·56	2·40	2·46	32·50	6·00	38·50	20·40	28·55	10·88
Crude sewage (camps)	43·76	12·00	5·25	11·36	28·61	—	4·29	12·08	48·0	93·0	141·0	16·40	11·70	4·43
Effluent from sewage farm.	0·970	0·245	0·055	—	0·286	9·23	4·48	15·53	24·5	16·5	41·0	Neutral.	12·28	12·00
Samples from Aylesbury, collected July 2, 1879.														
Crude sewage	6·76	4·00	0·66	4·85	9·510	none	14·42	7·97	76·0	29·0	105·0	35·50	48·6	20·0
Effluent from third settling tank.	0·633	1·02	0·07	0·581	1·671	3·19	30·21	5·44	76·0	13·5	89·5	11·20	66·40	37·1

Nitric acid shows the effect of oxidation on the organic matter, and here the great action of air and of a porous soil shows itself remarkably.

The best seems to be irrigation in dry weather when the land has full opportunity to act.

The use of precipitation has a decided advantage in wet weather as it raises the purity of the Coventry water above the Aldershot wet specimen. The precipitation method by alum, &c., at Aylesbury, is better in Tables B and C than in A. It is the best of the single processes in wet weather. Aldershot is the best of the single processes in dry. Coventry, the double process, is the best in wet weather. Those which are good in wet weather would probably show still better in dry if the specimens were taken frequently during the year. The precipitation processes, when alum or iron is used, have an advantage in wet weather since the act of precipitation becomes an act of disinfection.

The effluent specimens were examined as to their tendency to putrefy.

Those with lime changed most.

Birmingham (effluent) ammonia rose in 23 days from 3·222 to 4·2; then began to fall; Burnley in 27 days from 1·33 to 1·92; Aylesbury changed none in a week; Aldershot (dry), may be said not to have changed in 25 days.

The capacity to froth when shaken is a very useful mode of finding the comparative sewage matter rapidly. It may be said to have been absent in Aldershot (dry),

	Date.	Free Ammonia.	Albuminoid Ammonia.
Burnley, collected June 16, 1879..	June 20, 1879	1·33	0·305
	July 17, ,,	1·92	0·23
	,, 28, ,,	1·92	0·30
	Sept. 4, ,,	2·15	0·13
Birmingham, collected, June 23, 1879..	June 25, ,,	3 222	0·662
	July 17, ,,	4·20	0·336
	,, 18, ,,	4·15	0·336
	,, 28, ,,	3·90	0·324
Aldershot (wet), effluent C ..	,, 7, ,,	0·44	0·144
	,, 28, ,,	0·364	0·130
	Sept. 4, ,,	0·140	0·092
Aldershot, dry ..	,, 16, ,,	0·245	0·055
	Oct. 11, ,,	0·240	0·058
Aylesbury, collected July 2, 1879..	July 23, ,,	0·96	0·067
	,, 26, ,,	1·00	0·06
	,, 29, ,,	0·96	0·06
	Sept. 4, ,,	0·045	0·035

Coventry, and Aylesbury effluents. The clearness of the liquid is very important although a popular indicator. In the Coventry sample there were a few white floating particles; when these fell the water was clear and colourless. Three specimens—Aldershot (dry), Coventry, and Aylesbury were without colour, when they had stood in a large colourless glass vessel.

The total solids are in this order in the effluents; the advantage is in being low, of course:—

Aldershot, average of three (wet) ..	29·5
Aldershot, dry	41·0
Burnley	54·0
Coventry	70·5
Aylesbury	89·5
Birmingham, *b*	100·5
Birmingham, *a*	112·5

During floods the volatile solids stand thus:—

Coventry	12·0
Aylesbury	13·5
Aldershot, average of three (wet) ..	13·8
Burnley	14·0
Birmingham, *a*	24·0
Birmingham, *b*	26·5

The chlorine has not been found the same in the effluent as in the sewage. This, I suppose, is owing to the effluent being from sewage of a time previous to that of the specimen of sewage.

The question has been asked which of these specimens is most suited for passing into a sewer. None of these effluents can be called sewer-water in the ordinary sense. The Birmingham stream froths readily, and is not pleasant to the eye. The Burnley water was pretty clear, would do well in appearance as a stream by itself, but caused a milky deposit in the river into which it fell, arising we may suppose from the free lime taking up some carbonic acid from the river water and precipitating carbonate of lime. The Coventry effluent went into a stream which was very impure, and it might, so far as appearance went, pass into a shallow mountain stream without being noticed. So of Aldershot and Aylesbury.

In every respect we may say that the best result has been obtained by irrigation when the weather is not so wet as to cause overflowing. Still it was not found highly successful after lime at Birmingham.

That the precipitation with alum or alum and iron compounds is next.

That in wet weather there is an advantage in precipitation because the action is largely, if not wholly, independent of dilution.

That the lime process is valuable but not equal to the above precipitation processes.

I must repeat that in this report I allude only to the merits of the effluent. There is a good deal to be examined before pronouncing on the ultimate value of the processes, and of course a large proportion, if not all of the remaining reasoning, must be left for Mr. Rawlinson, for whose report this may be considered as a preparation.

Manchester, October 16, 1879.

ON THE USE OF THE SPECTROSCOPE IN DISCRIMINATING ANTHRACENS.

By BENJ. NICKELS, F.C.S., F.I.C.

In the conversion of anthracen into anthraquinon by the method known as "Meister, Lucius, and Brüning's Anthraquinon Test with Appendix," results, or products, are obtained as varied, perhaps, as the crude anthracen originally submitted to examination, in place of well-formed and perfectly crystalline chinons, as might be anticipated from the very large excess of chromic acid employed in oxidising, the product is mostly an indefinite mixture of crystalline and uncrystalline substances, the latter well-known and generally referred to as "amorphous particles."

Varied opinions have been held concerning the nature of the substances and the inference to be derived from their presence; that they are not without considerable influence as regards the quality of an anthracen affording them there is little doubt, and the appearance presented by a given sample after oxidation is generally taken into consideration in forming an estimate of its character and quality, indeed of classifying it.

In order, however, to determine these points it becomes necessary to carry through the special test referred to, and await the crystallisation and dilution of the oxidised product. To do this involves several hours, or a day at least, and in cases where it is wished to arrive at a rapid conclusion inconveniently long.

For the guidance of those interested in the question (and from the number of enquiries put to me, I believe there are many), I am able to state that the information sought may within a very close limit be arrived at without chromic acid oxidation and within a few minutes, by simply subjecting the given sample to spectroscopic examination. Pure anthracen, and most of the hydrocarbons associated with it in the crude state, afford clear and continuous spectrums, free from absorption bands. Certain substances, however, also present with it in that state, possessing very high fusing-points, exhibit deep and broad absorption bands. The former bodies in no wise affect the crystallisation of anthraquinon as formed under the oxidation test; the latter, on the other hand, seriously interfere with that property, and afford the so-called and objectionable "amorphous particles," frequently present in sufficient quantity to obliterate all traces of crystallisation in the oxidised product.

As a result of long-continued experience in anthracen testing, and in which I have employed the spectroscope as an adjunct, I am in a position to state that the intensity of the absorption bands afforded by a given sample of crude anthracen are in close proportion to the quantity of "amorphous substances" to be found and remaining after the chromic acid oxidation.

In a communication to follow this paper I purpose giving details and method of examination as written some fifteen months back, but withheld from publication in deference to views held at the time.

10½, Leadenhall Street, E.C.

ON THE ESTIMATION OF THE NITROUS COMPOUNDS IN THE VARIOUS STAGES OF THE MANUFACTURE OF SULPHURIC ACID.*

By JAMES MACTEAR, F.C.S., F.I.C.

(Continued from p. 44.)

8. In a more recent paper, communicated to the Tyne Chemical Society, Dr. Lunge criticises some remarks made by Dr. Affleck in his address at the beginning of the session, in reference to the impurities of the nitrous vitriol affecting the testing by the permanganate process, as follows:—

"But these impurities which are mentioned by Dr. Affleck are really of no importance. The percentage of arsenic present in sulphuric acid is very small in any case, but seeing that by the action of the higher oxides of nitrogen, arsenious acid is converted into arsenic acid, and, that the latter would not be affected by the permanganate, we may safely leave the arsenic out of consideration when testing the nitrous vitriol of our absorbing columns. It is true that this very fact, the oxidation of arsenious to arsenic acid, will cause a slight loss of nitre in sulphuric acid making, a matter not very generally noticed, but the question of testing an absorbing column acid is not affected thereby to an appreciable extent, as the latter must contain its slight percentage of arsenic nearly, if not all, in the form of arsenic acid."

The assumption that the amount of arsenic "is very small in any case," is not, I think, warranted by the facts.

* A Paper read before the Newcastle-upon-Tyne Chemical Society

The analyses published by H. A. Smith* are pretty conclusive on this point. He gives as a mean of 15 analyses the amount calculated as arsenic trioxide of 1·051 per cent, the maximum being 1·112, and the minimum 0·800 per cent. He gives the following useful table:—

Tons.		Tons. AS_2O_3.
100	Hard Norwegian pyrites contains before burning	1·649
	Ditto after burning	0·465
100	Ditto made 140·875 H_2SO_4 containing	1·481
140·875	Sulphuric acid made 104·9 HCl	0·724
,,	Ditto 204·12 Na_2SO_4	0·059

This amount of 1·051 per cent, if calculated on the N_2O_3 in the Gay-Lussac acid, will be actually some 20 per cent of the N_2O_3 present, a quantity which cannot be considered "very small," being quite sufficient to cause a notable error, more especially as it by no means has been proved to exist as arsenic acids.

Gmelin gives a list of investigators, and says it apparently exists in sulphuric acid, for the most part, as arsenious acid; and Hofmann quotes Bussy and Buignet and others as to the existence of both arsenious and arsenic acids, and also quotes Blondlot as recommending manganate of potash as a means of converting the arsenious into arsenic acid prior to its removal by distillation.

I think the balance of proof is clearly in favour of the opinion that the arsenic compounds present do interfere with the permanganate of potash process as the "most accurate of all" the processess for the testing of nitrous vitriol, as claimed by Dr. Lunge.

It is not to be wondered at that there should be arsenious acids present, as it is not by any means unusual to find SO_2 in the Gay-Lussac acid. In fact the "nitrous vitriol" may be looked on as containing, under various conditions, the following compounds:—

Nitrous acid	N_2O_3
Nitric acid	N_2O_5
Nitric oxide	N_2O_2
Sulphurous acid	SO_2
Arsenious acid..	As_2O_3
Arsenic acid	As_2O_5

With traces of metallic salts, and it may be—

Nitric peroxide	N_2O_4

But as this latter will act simply as a mixture of nitric and nitrous acids, it may be considered as coming under these heads.

Now, in testing with permanganate, the amount required will be in proportion to the oxygen required to oxidise these compounds, and may be shown in this way. Taking N_2O_3 as a standard, and assuming it to require a quantity of permanganate equal to 100, we would have for—

N_2O_3	100·00
N_2O_4	41·30
N_2O_2	190·02
SO_2	59·38
As_2O_3	38·38

Suppose a case where the permanganate required in testing a sample of nitrous vitriol was equal to 5 vols. per cent of N_2O_3, let us examine the effect on the test caused by the presence of these various impurities, assuming that they exist to the extent of 1 vol. per cent, then—

	Per Cent.		
N_2O_3 by permanganate	5·000 vols.		= 100·00
N_2O_5 no effect	5·000 ,, ...		= 100·00
N_2O_4 will give results as	4·586 ,,	0·414 too low	= 91·72
N_2O_2 ,,	6·900 ,,	1·900 too high	= 138·00
As_2O_3 ,,	4·616 ,,	0·384 too low	= 92·32
SO_2 ,,	4·406 ,,	0·594 too low	= 88·12

* "The Chemistry of the Sulphuric Acid Manufacture."

These facts are sufficient to show that the permanganate method of testing cannot be looked upon as an absolutely perfect method; still there is no doubt that for technical purposes of ordinary testing of nitrous acid it is much the more convenient, and sufficiently accurate for such purposes.

The presence of arsenic in sulphuric acid was first announced by Dr. G. O. Rees,† who states the amount found by him as 22½ grains in 20 fluid ounces of supposed pure acid (stated as white arsenic); and in another sample he found even more than this amount. H. Watson‡ stated in the same journal that he had kuown for some months of the presence of this impurity, and had made examinations of various samples; he states the minimum quantity which he found at 35½ grains in a pint of acid, and his latest result as giving 5½ grains in 100 grains weight of acid = 0·55 per cent. Dr. O'Reilly§ gives 0·60 per cent as the amount he found. Smith gives the results already referred to. More recently I have had some tests made of the acid in the works of my firm at Hebburn, which show the quantity present under the ordinary conditions of manufacture of sulphuric acid from pyrites. The set of chambers from which the samples were drawn for examination was arranged in a series of three.

The arsenic is all calculated to arsenious acid—

SERIES A_3, 11TH DECEMBER, 1877.

	Per cent.
Acid from denitrating column (Glover tower)	0·286 by vol
,, bulk of 1st chamber	0·292 ,,
,, ,, 2nd ,, ...	0·060 ,,
,, ,, 3rd ,, ...	0 010 ,,
,, absorbing column (Gay-Lussac)	0·200 ,,

In order to check these results, a second series of examples were drawn and tested.

SERIES A_3, 19TH DECEMBER, 1877.

	Per cent.
Acid from denitrating column (Glover tower)	0·210 by vol
,, bulk of 1st chamber	0·224 ,,
,, ,, 2nd ,, ...	0·031 ,,
,, ,, 3rd ,, ...	0·010 ,,
,, absorbing column (Gay-Lussac)	0·280 ,,

It is not unusual to find crystals of arsenious acid in the flues leading to the chambers; and I have here a specimen which I obtained lately of crystalline deposit from the vessel under the drip of an inlet pipe from the Glover tower to the first chamber. Some of the crystals in this specimen are quite large, and their form is perfectly distinct. Arsenic acid has been found crystallised on the bottom of the leaden chambers.‖

The question as to the state of oxidation of the arsenic is a most difficult one to decide. The deposit in the pipe leading from the Gay-Lussac tower to the chimney was examined with the following result:

Deposit from draft-pipe from Gay-Lussac towers to chimney. A whitish mud-like deposit, evidently containing a considerable quantity of nitrous compounds, which were given off on adding water to a portion of the mud. After washing until free from acid reaction it was dried, and then found to contain in the dry state 59·7 per cent of *arsenious acid*.

This shows that whether it had passed through all the series of plant or no, that it can exist as As_2O_3 in presence of nitrous compounds passing away from the Gay-Lussac towers and condensing in the main outlet flue.

The question as to the presence of N_2O_5 in sulphuric acid is, I think, quite beyond a doubt; and the following experiments are conclusive on the point:

I turned on full steam in the last but one and the last chambers of a series of vitriol chambers, composed in all

† *London Medical Gazette*, February 5, 1841.
‡ *Ibid.*, February 19, 1841.
§ *Dublin Medical Journal*, 1842, 442.
‖ H. A. Smith, "Sulphuric Acid Manufacture."

of eight chambers. Within five minutes the colour of the gases, as seen through glasses, originally of a normal rich tint, became decidedly pale; in ten minutes the gases were reduced to a slight straw tint; samples were then collected over about fifteen minutes from—

(*a*) The drip in connection pipe between the second last and last chambers.

(*b*) The layer of dilute acid formed on the floor of last chamber (this at end of fifteen minutes.)

(*c*) The drip at last outlet from chamber to Gay-Lussac column.

(*d*) The Gay-Lussac acid.

These were then examined by testing with permanganate, and also by the ammonia process with zinc and iron previously described, and the following were the results obtained:—

(*a*) This sample contained a good deal of sulphate of lead, evidently washed off the sides of the connection pipe by the increased flow of dilute acid. It settled rapidly, and was then remarkably clear and brilliant. Its strength was 38° T. It smelt *strongly* of nitrous compounds. A portion of it on being shaken in a bottle gave off a considerable quantity of gas, which was apparently colourless, but became coloured on contact with air.

(*a*) It gave on examination in 100 c.c.:—

1. By ammonia process 0·42280 grm. N
2. „ permanganate „ 0·00077 „ N = 0·00209 N_2O_3

Excess N from 1 0·42203 „ N = 1·6278 N_2O_5

99·91 per cent of the total N being in the state of N_2O_5.

(*b*) This sample presented much the same characteristics as *a*, with the exception of its not containing sulphate of lead in appreciable quantity. Its strength was 73° T.

It gave in 100 c.c.:

1. By ammonia process 1·2348 grm. N
2. „ permanganate „ 0·0135 „ N = 0·03664 N_2O_3

Excess N from 1 1·2213 „ N = 4·71067 N_2O_5

98·91 per cent of the total N being in the state of N_2O_5.

(*c*) This sample smelt *very* strongly indeed of nitrous compounds, and gave off gas in quantity on agitation as in *a*. Its strength was 57° T.

It gave in 100 c.c.:—

1. By ammonia process 1·23760 grm. N
2. „ permanganate „ 0·00721 „ N = 0·01957 N_2O_3

Excess N from 1 1·23039 „ N = 4·7457 N_2O_5

99·42 per cent of the total N being in the state of N_2O_5

(*d*) This sample was perfectly normal in appearance. Its strength was 149° T.

It gave in 100 c.c.:—

1. By ammonia process 0·3469 grm. N
2. „ permangar ate „ 0·326375 „ N = 0·08859 N_2O_3

Excess of N from 1 0·020525 „ N = 0·07917 N_2O_5

5·92 of the total N present being in the state of N_2O_5

(To be continued.)

Action of Ozone on Certain Noble Metals.—Prof. A. Volta.—Silver quickly becomes covered with a layer of black oxide. Gold is perfectly unaffected by ozone, whether moist or dry. Platinum gave the same results as gold. Palladium, if perfectly freed from hydrogen, is polarised negatively in ozone, like the other noble metals, and even in a moist atmosphere it does not decompose ozone. Mercury is superficially oxidised by ozone, whether moist or dry.—*Gazzetta Chimica Italiana.*

ANCIENT METHODS OF FILTRATION.*

By H. CARRINGTON BOLTON, Ph.D.,
Professor of Chemistry in Trinity College, Hartford.

The separation of a liquid from solids suspended in it, by straining through some material previous to the one and impenetrable to the other, was a familiar process in the remotest antiquity. Observations of various processes in nature, such as the purification of water by trickling through sandy soil, or perhaps the accidental passage of rain-water through an out-stretched cloth, a garment, or a tent-cover, would obviously suggest the simple expedient. History fails to record the period of the invention or the name of the individual who first put it in practice. Etymological considerations show that filters were early made of fulled wool or felt; the Latin *filtrum*, a "filter," being closely connected with *feltrum*, "felt," or compressed wool, and both are related to the Greek πιλος, signifying hair.

Several writers on the history of science make casual reference to the operations performed by the early chemists: some state in a general way their acquaintance with the processes of distillation, sublimation, filtration, &c.; others are more explicit. Hermann Kopp, in his exhaustive "Geschichte der Chemie" (vol. ii., p. 26), states that "filtration as a chemical process was first accurately described by Geber, who calls it by a special name, *destillatio per filtrum*, 'trickling through a filter,' in contrast to the collection of a liquid by ordinary distillation." Ferdinand Hoefer, in his "Histoire de Chimie" (vol. i., p. 335), writing of Geber, mentions that he recognises two kinds of distillation—with and without fire—the former being "per alembicum," and the latter consisting of "une simple filtration."

Now, we propose to show that the ancients carried on the operation of filtration in two ways, essentially distinct in principle and in the manner of execution, and that these methods were characterised by two different expressions which have been confounded by the authors named. Moreover, we shall establish this by quotations from writings covering a period of more than two thousand years.

In the first place, an examination of the very passage in Geber's Works, referred to by Kopp and by Hoefer, shows that the method therein described differs radically from filtration as ordinarily conducted at the present time. We quote the passage as found in the Works of Geber, "the most famous Arabian Prince and Philosopher," faithfully englished by R[ichard] R[ussell]," and printed at London in 1678. In the thirteenth chapter of the fourth part of the first book of the "Summe of Perfection," Geber treats of the three kinds of distillation—by an "Alembeck," by a "Decensory," and "by Filter." After describing in quaint language the well-known method of using the alembic and the decensory (which differs chiefly in the application of heat on the top of the apparatus), Geber writes thus of filtration:—"The *Disposition* of that which is made by *Filter* is, that the *Liquor* to be *Distilled* be put into a *Stone Concha*, and the wider part of the *Filter* put into the said *Liquor*, even to the *Bottom* of the *Concha*, but the narrower part of it hang out over the *Orifice* of the said *Vessel*. And under that end of the *Filter* must be set another *Vessel* for receiving the *Distillation*. Therefore when the *Filter* begins to *Distill*, the *Water* with which it was moistened will first *Distill* off; which ceasing, the *Liquor* to be *Distilled* succeeds. Which *Liquor*, if it be not as yet serene, it must so often be put into the *Concha* again and redistilled, as until it be *Distilled* most serene."

This dates from the eighth century, and evidently describes a sort of capillary syphoning. The expressions "placing the wider part of the filter" into the liquid and allowing the "narrower part of it to hang out over" the

* Read before the New York Academy of Sciences, October 13, 1879

vessel admit of no other interpretation. For convenience of distinguishing this method of filtration from that in which porous sacs are employed, we propose to name the former *anethisis*, a word made from *ἀνά*, "upward," and *ηθισις*, "a straining off." A study of the chemical works of the middle ages further shows that the expression "*destillato per filtrum*" is invariably used to describe *anethisis*, while "*filtratio*" is applied to ordinary filtration. We shall give quotations proving this, but first make brief reference to early records.

The ancient Egyptians portray in their rock-cut memorials the operation of filtration in connection with the manufacture of wine. Their simple wine-press consisted of a bag in which the grapes were placed, and squeezed by means of two poles turned in contrary directions. Small colanders of bronze have been found at Thebes. Views of the interior of an Egyptian kitchen, cut in the tomb of Rameses III. at Thebes, represent syphons in use for drawing off liquids of various kinds. (Wilkinson.) The ancient Romans employed strainers and colanders (*colum*) made of a great variety of materials. Wine-strainers were made of silver and bronze; the poorer classes used linen, and where nicety was not required they used those made of broom or of rushes. Strictly speaking, however, percolation through colanders is not filtration, for capillary action plays no part.

It is interesting to note that the earliest mention of filtration which a brief search has disclosed refers to the method we have ventured to call *anethisis*. This occurs in Plato's "Symposium," written about four hundred years before the Christian era. The passage is as follows:—"Socrates then sitting down, observed, 'It would be well, Agatho, if wisdom were a thing of such a kind as to flow from the party filled with it to the one who is less so, when they touch each other, like water in vessels running by means of a thread of wool from the fuller vessel into the emptier.'"*

Aristotle, the pupil of Plato, in his essay "De Generatione Animalia," refers to the other process in the following words:—"Flesh is produced, therefore, through the veins and pores, the nutriment being deduced in the same manner as water through earthern vessels not sufficiently baked."

This passage, together with others occurring in Plato, shows that both systems of filtration were employed at that early period.

Geber, whose clear description of anethisis we have quoted, was followed by the celebrated Arabian physician, Rhazes: he uses the same expression, "destillatio per filtrum," in the following passage:—"Dissolve as much [common salt] as you wish in five times as much warm soft water, and distill per filtrum and congeal [*i.e.*, crystallise]."† Rhazes died about 930 A.D.

Among the early writers on alchemy, no one is oftener quoted than Raymund Lulli, surnamed the Enlightened Doctor (born 1235, died 1315 A.D.) In his works we find the following characteristic passage:—"Take, in the Name of God, great Bay Salt, as it is made of the Sea; take a good quantity and stamp very small into a stone mortar: then take Cucurbites of Glass and pour your salt therein: then take fair Well-water, and let your salt resolve into cleer water; being all dissolved then distil it by Filter; that is to say, hang a jag Felt or Woolen cloath in the Cucurbite; and let the other end hang in another glass beside it, set as it were under it, that the water may drop into it that the Felt or Cloath may draw out and that shall be cleer as silver."

This unmistakeable description of anethisis occurs in the first chapter of a booklet bearing the following title: "Philosophical and Chymical Experiments of the Famous Philosopher Raymund Lulli . . . . wherein is contained . . . . the admirable and perfect way of making the great Stone of the Philosophers as . . . . sometime practised in England by Raymund Lulli in the time of King Edward the Third." London, 1657.

Thomas Aquinas, the eminent scholastic teacher of the thirteenth century, who is best known by his theological and metaphysical works, also paid some attention to scientific pursuits, possibly acquiring this taste from his learned master, Albertus Magnus. Aquinas, or the divine Thomas, as he was called by his admirers, defines distillation to be the "purification of waters falling drop by drop, and effected by placing a filter cut in the shape of an iron dart in the little dish containing the water to be distilled."*

Libavius, in his remarkable work, "Alchymia," sometimes called the first text-book of chemistry (published in 1595), devotes two entire chapters to the subject of distillation and of filtration.† In the fourteenth chapter he describes, with much attention to detail, the manner of filtering by means of pieces of felt (*lacinia*) shaped like an ox-tongue, the broader portion of which is placed in the vessel containing the liquid to be filtered, and "the apex in the recipient, or, if the vessel has a narrower neck, in a suitable funnel." This demonstrates that the method was not resorted to on account of the want of proper funnels, and suggests that perhaps a special virtue was attributed to a liquid thus purified.

Libavius's work contains rude woodcuts illustrating different methods of procedure. For perfecting the purification a series of four vessels was used. These were placed on steps, one above another, and the liquid passed through a capillary syphon from the uppermost to the one immediately below, and thence by another syphon to the third vessel, and so on to the fourth. This series of vessels can be enclosed in a glass-covered box for filtering volatile liquids. Another woodcut represents the lower end of a capillary syphon hanging into a funnel inserted in the neck of a flask. The method thus clearly pourtrayed is called *destillatio per lacinias*, and is evidently regarded as a process of distillation; ordinary filtration through porous stones and through bibulous paper is treated in another and following chapter.

Libavius makes reference to "Hippocrates' Sleeves,"‡ by which name were designated conical felt bags used in filtration.

Sir Robert Boyle, in his "Experiments touching the Spring of the Air," writes as follows: "Some learned mathematicians have of late ingeniously endeavoured to reduce filters to syphons, but still the true cause of the ascension of water and other liquids, both in syphons and in filtration [requires], a clever discovery and explication."§ And in another place he gives this "explication": "The parts of the filter that touch the water being swelled by the ingress of it to their pores are thereby made to lift up the water till it touch the superior parts of the filter that are almost contiguous to them; by which means, these being also wetted and swelled, raise the water to the other neighbouring parts of the filter till it have reached the top of it, whence its own gravity will make it descend."‖

These passages can only apply to anethisis, which was apparently a common method of filtration in Boyle's day.

Again, to trace this process still later, Juncker, in his "Conspectus Chemiæ," published in 1730, describes seven kinds of filtration. These differ chiefly in respect to the

* Plato's works, Burges's translation, vol. iii., p. 480 (Bohn).

† "Collect. ex Rhasi in Margarita Pretiosa Novella" of Petrus Bonus (1330), Venetia, 1546.

* "Pretiosa Margarita Novella" of Petrus Bonus (1330), Venetia, 1546.

† "Comment. Alchymia," Part I., lib. iii, edition 1606.

‡ The origin of this curious term we have been unable to discover, nor is it of common occurrence in early writings on chemistry and pharmacy. The only explanation of the expression which we have as yet found occurs in the "Lexicon novum Medicum Græco-Latinum" of Stephen Blancardus, published in 1702. This author writes as follows:—"*Manica Hippocratis* est sacculus laneus figura pyramidali, quo vina aromatica et medicamentosa, aliique liquores percolantur; ex '*υπο sub* et *κερανυμι miscco*."

§ Boyle's Works, London, 1772, vol. i., p. 79.

‖ *Idem.*, vol. iii., p. 223.

materials used: two methods, however, are essentially distinct. The one is styled "*filtratio per chartam bibulam . . . in fundibulo vitreo*" (filtration through bibulous paper in a glass funnel), and the other is described in the words "*per segmentum panni lanei vel laciniam bombycinam vel funiculos gossypii*" (through shreds of woollen cloth, silken threads, or through little strings of cotton).

Our friend Prof. S. A. Lattimore sends us another reference to this process from "The Laboratory or School of Arts, &c., compiled by G. Smith, sixth edition, London, 1799" (vol. i., p. 435), the passage is as follows:—

"*To Separate Water from Wine.*—Put into the cask a wick of cotton, which should soak in the wine by one end and come out of the cask at the bung-hole by the other, and every drop of water which may happen to be mixed with the wine will still out by that wick or filter."

Thus we see that, so recently as the close of the last century, anethisis was accounted a practical method of filtration.

We have not found this method in Boerhaave (1727), nor in Lemery (1675), nor does Faraday, in his "Chemical Manipulations," make any allusion to it. As a process of purification of solutions it seems to have been lost sight of in modern laboratory practice.

We have made trial of the method rendered noteworthy by more than two thousand years' practice, and find that, while the process is quite slow, it has certain advantages. Chief among these is the fact that, when the capillary syphon is adjusted, it requires no further attention; there is no pouring into a constantly emptying funnel, and there is no possibility of overflow. When properly arranged, the last drop of liquid passes from the upper vessel to the lower, and, except in certain cases of extreme divisibility, the filtration is perfect. The process seems particularly adapted to the purification of weak solutions, as of mineral waters, where the insoluble portion is not to be conserved. There is obviously much choice in the material of which the capillary syphon is made. We have tried cotton, wool, lamp-wick, and asbestos, and we find stout silky wads of the latter most serviceable; it is also useful for filtering very acid and alkaline solutions.

The rapidity of filtration does not seem to be hastened by lengthening the longer arm of the syphon, and is chiefly dependent on the number of threads in the filter, and on their fineness. In one experiment, thirty-two strands of cotton yarn filtered twice as fast as sixteen strands, and only half as fast as sixty-four strands. Oil filters much slower than saline solutions, and the latter much slower than pure water.

We have used the expression "capillary syphoning" in describing anethisis, and perhaps it needs justification. The ascension of the liquid is due to capillarity, and the descent through the longer arm of the syphon is in obedience to gravity. Syphoning is dependent on atmospheric pressure, and cannot be strictly applied to the present case; yet we find by experiment that, if the lower arm of the woollen threads be raised to the level of the liquid to be filtered, the action ceases, and the form of a syphon is at all events essential to the process.

The quotations from ancient authors show that they must have been quite familiar with capillary attraction, yet the first observance of this phenomenon is attributed by some authorities to Franciscus Aggiunti, physician to the Grand Duke of Tuscany, about the beginning of the seventeenth century.‡ (Aggiunti died 1635.)

In conclusion, the object of this paper is not to propose a return to this ancient method of filtration, the modern rapid processes being more in accordance with present needs; but we have thought it not altogether useless to call attention to a neglected process which can in certain cases be employed with advantage. Where the object of filtration is to collect the insoluble portion, it is obviously of no value; whether the process could be advantageously used on a large scale remains to be tested.

‡ Gehler's "Physikalisches Wörterbuch," article "Capillarität."

SALE OF UNFERMENTED WINE.

On the 12th ult., at the Salford Borough Police Court, William Pilling, chemist and druggist, was summoned for having sold, "to the prejudice of the purchaser, one bottle of unfermented port wine which was not of the nature, substance, and quality of the article demanded." Another summons charged the defendant with selling similarly a bottle of unfermented sherry.

Mr. J. Carter Bell, the public analyst for the borough, stated that he received the samples in question on the 23rd November, and subsequently analysed them. With reference to the "unfermented sherry wine" he only found ·91 of ash, which was considerably less than one-tenth of what ought to be found in pure grape juice. This ash contained a trace of potash and a trace of phosphoric acid. It consisted chiefly of sulphate of sodium and calcium, with a few other mineral ingredients. 52 per cent of it was only soluble in water. This was no more ash than could be got from ordinary drinking water. In answer to the Bench, the witness said the sherry wine contained about 6·10ths per cent of tartaric acid and about 22 per cent of sugar. He considered that this so-called sherry wine was a solution of sugar and tartaric acid, flavoured and coloured, and containing a little salicylic acid. The port wine was very similar to the sherry.

For the defence it was contended that what was sold to the inspector was of the nature, substance, and quality of the article demanded. There were other materials, it was said, used in the manufacture, but it was manufactured mainly from the juice of the grape.

The Stipendiary remarked that his opinion at present was that, supposing there was a substantial portion of the grape juice in the wine, the label could not be deceptive, but if there were only 1 per cent of grape juice added to it he should consider it a matter of fraud.

Mr. Green called attention to the fact, although his defence did not depend upon it, that orange wine had not a particle of orange juice in it.

John Houston, the manager for Messrs. Bell, said it was his business to manufacture the wine in question. The process of manufacture was to preserve the grape juice with salicylic acid. To five parts of water he generally put one part of grape juice. To six gallons of this liquid was added two pounds of sugar.

Mr. Louis Siebold, F.C.S., had examined one of the samples of the wine in question. The predominant constituent of it was sugar, precisely the same as was contained in grapes. He also found tartaric acid exactly the same as was found in grapes. He found the constituents of grape juice present, but whether grapes or separate materials had been used he could not say. His personal opinion was that something like 10 per cent of grape juice was used in the wine.

Mr. Makinson, in dismissing the summons, said that there was no standard of what grape juice the wine should contain, and it could not be said that the manufacturers had fraudulently made this wine from water, for there was evidence that some proportion of grape juice was used.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Ordinary Meeting, January 24, 1880.

Prof. W. G. Adams in the Chair.

New member—Mr. W. Ellis.

Mr. Grant read a paper and exhibited experiments on the "*Induction in Telephonic Circuits.*" He was led to these experiments by a former observation that when an

induction coil primary was placed in a circuit consisting of a telephone, microphone, and battery, the microphonic sounds heard in the telephone were increased on closing the secondary circuit of the coil. Employing a double wound coil, that is having primary and secondary side by side, he found that the latter could act as a condenser and "relay" or translate messages into a second circuit, the microphone and battery being in the circuit of one wire (*i.e.*, the primary), and the other wire (or secondary) containing a telephone. He also inserted a double wound coil in the latter, or secondary circuit, and caused the induced or translated current to flow through both of the wires of this double coil one after another in the same direction. The effect was weak, but on reversing the current in one-half of the double coil by means of a commutator, so as to make it double on itself as it were, the weakening effect of induction was neutralised, and the sounds heard were as loud as if no coil had been inserted in the secondary circuit at all, as was proved by short circuiting the double coil altogether.

Dr. O. J. Lodge read a paper on "*Intermittent Currents and the Theory of the Induction Balance.*" The telephone as a scientific instrument seems destined to play an important part as a detector of minute currents of rapidly changing intensity, and the general theory of intermittent currents is being brought into prominence by its use. The equations to which most attention has been hitherto directed have been those relating to the steady flow of a current after the initial inductive or inertia-like effects have subsided. The galvanometer is essentially an instrument for measuring steady currents, or for giving the algebraically integrated expression for the total quantity of electricity which has passed in the case of transient currents. But the telephone plate has a very small period of swing compared to a needle, and, moreover, the plate is not limited to one mode of vibration like the needle. The induction balance was used experimentally by Done and Felici, but was not appreciated as an instrument of research till Prof. Hughes applied to it the telephone and an intermittent current. The general theory of the establishment of a current in circuits of known resistance was given by Thomson, and is to be found in Maxwell's "Electricity." Dr. Lodge used this theory in order to work out the theory of the induction balance, and one or two other cases of intermittent currents as completely as possible without taking into account the electrostatic capacity of the wires and leakage. The current in either primary of the balance is the same, and the current in either secondary is the same at every instant of time. In fact, the separating of the two halves of the circuits is immaterial to the theory. The current induced in the secondary circuit is a tertiary current induced from the piece of conducting matter inserted between the primary and secondary. An expression being got for the strength of current in the telephone at any instant after a change in the resistance of the primary has occurred, the author deduces among other things the law according to which a small coin by its position and size disturbs the balance. Dr. Lodge remarked that Prof. Hughes, either by inventive intention or great pains, had hit upon the best form of the apparatus for his purpose. The paper, which is very complete, is to be published in the *Philosophical Magazine* for February.

Herr Faber then exhibited his new Speaking Machine, which is designed to imitate mechanically the utterances of the human voice by means of artificial organs of articulation made on the human model, and actuated by an operator who depresses certain keys, as in playing a musical instrument. The organs are a bellows made of wood and india-rubber, which answers to the lungs; a small windmill placed in front of the latter to give the "r" or trilling sounds; a larynx, made of a single membrane of hippopotamus hide and india-rubber, to give the "drone" or basic tone of the voice; a mouth, with two lips, a tongue, and a nose or proboscis made of india-rubber tubing, placed below the mouth, but curving up towards it. Fourteen distinct vocal sounds can be uttered by the instrument, but in combining these any word in any language can be played by the keys. Thus Herr Faber caused his machine to say such words as "Mariana," "Eliza," "Philadelphia," "Constantinople," and various sentences in French, English, and German, more or less distinctly. Laughing and whispering were also produced, and the voice of the instrument, which was ordinarily loud and clear, and resembling that of a girl, was lowered in pitch and loudness to a more masculine tone.

CORRESPONDENCE.

WATER OF THE CARISBROOKE CASTLE WELL.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xli., p. 10, Mr. G. W. Wigner refers to my note on the water of the Carisbrooke Well, and I am interested to see his figures for the ammonia, which my sample did not allow me to obtain. I am certainly surprised to find any analysis of the water showing an amount of volatile matter in the water so much lower than the 19·6 grains per gallon, which I found, as 0·18 grain. Is not this a most exceptionally small amount for even a water of great natural purity, which this is certainly not? The point which I wished to emphasise was the necessity, in pronouncing on the quality of a sample of water, of giving due weight to *every* characteristic which it displays, and not sum up merely from the determination of what one might call "the three or four orthodox constituents of a water." The desirability of a more general recognition by chemists of this fact has been very ably dwelt upon by Mr. Wigner himself (*Analyst*, vol. iii., p. 208).—I am, &c.,

H. Grimshaw.

Gibbons Street Chemical Works, Bradford, Manchester, January 19, 1880.

ALCOHOL TABLES.

To the Editor of the Chemical News.

Sir,—It would be a great desideratum to have a table showing the comparative strength of alcohol as indicated by "proof" as practised in England, and percentage by volume according to Tralles and Gay-Lussac's tables, as in use on the Continent. It is strange that neither in Ure, Watts, or Muspratt, are any such tables to be found.

As a full table would occupy too much space, I give merely the formula by which any given strength in proof-spirit may be calculated in percentage by volume or *vice versâ*.

Proof-spirit as accepted by the English Custom House = 0·9186 sp. gr., at 60° F., and contains 57·27 per cent by volume.

O = overproof.
T = (Tralles) percentage.
U = underproof.

Formula 1.—To change overproof into percentage.

$$T = O \times 0{\cdot}5727 + 57{\cdot}27.$$

Example.—How much is 66·1 overproof in percentage?

$$T = 66{\cdot}1 \times 0{\cdot}5727 + 57{\cdot}27 = 95{\cdot}12.$$

On reference to the ordinary tables it will be seen that 66·1 overproof = 0·8156 sp. gr., and that 95·12 per cent = 0·8157 sp. gr.

Formula 2.—To change percentage into overproof.

$$O = \frac{T - 57{\cdot}27}{0{\cdot}5727}.$$

Example.—95·12 per cent. How much overproof?

$$O = \frac{95·12 - 57·27}{0·5727} = 66·1.$$

Formula 3.—$T = 57·27 - (U \times 0·5727)$.

Example.—20 underproof to change into Tralles.

$$T = 57·27 - (20 \times 0·5727) = 45·55.$$

Formula 4.— $$U = \frac{57·27 - T}{0·5727}.$$

Example.—45·55 Tralles to change into underproof.

$$U = \frac{57·27 - 45·55}{0·5727} = 20.$$

—I am, &c. S. Cohné.

65, Gracechurch Street, London, E.C.,
January 22, 1880.

"REDONDA" PHOSPHATE.

To the Editor of the Chemical News.

Sir,—It may not be generally known that there are at the present moment lying idle in the country a good many thousand tons of "Redonda" phosphate (a rich phosphate of alumina and iron), most of which was imported some years ago for various methods of treatment, but all these processes have hitherto proved unremunerative in actual working. As there are besides extensive deposits of phosphate of this class lying unworked in the West Indies, it seems a pity that some practical use should not be made of the mineral.

Now, as the "Redonda" is a tribasic phosphate, exceedingly soluble in acids and of very high percentage (containing phosphoric acid equal to over 80 per cent of phosphate of lime) I cannot help but think that, even without any other treatment than fine grinding it should be be as readily available in the soil as precipitated phosphate. This view would seem to be supported by the well-established fact that all soluble phosphates become converted into phosphate of iron in the soil before assimilation by the rootlets of the plant. A further confirmation of the idea is, I think, afforded by the fact that in a certain district manure made from the mineral and containing a large quantity of phosphate of iron, produced such crops that there was the keenest competition for it amongst the farmers the following season. Albeit, because the iron it contained prevented it "analysing" well, they would not pay for it on the basis of soluble phosphate.

Is there any scientific agriculturist or enterprising agricultural society prepared to test the point by careful practical trials after the well-known Rothamsted fashion? At least one if not all the various large holders of the mineral would, I believe, be willing to place a liberal quantity of it at the disposal of any high class investigator for the purpose.

If the result confirmed the view that this phosphate is surely (though, of course, more slowly than soluble phosphate) assimilable by the plant without any other process than that of fine grinding, a new and cheap source of most important fertilising element would be at the service of the farmer.—I am, &c.,

Unprejudiced.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Acad émie des Sciences. No. 1, January 5, 1880.

On Motion produced by the Diffusion of Gases and Liquids.—H. Sainte-Claire Deville.—The author refers to the fact that if a tube of platinum is filled with hydrogen, and kept at a constant temperature above 1000°, whilst its outer surface is kept surrounded by a current of nitrogen, the hydrogen leaves the interior of the tube, producing there a vacuum within a few millimetres. The author explains this result and certain analogous phenomena with the aid of an apparatus figured and described in the original. He remarks that the gases are all diffusible in each other, and asks if this diffusion is anything but simple solution? The transition from liquids to solids being effected by a continuous series of intermediate states, what are the properties of gases and liquids which belong at the same time to solids?

Hydride of Copper: a Reply to M. Berthelot.—A. Wurtz.—The author maintains at some length that the phosphorus and oxygen found in this substance are merely accidental impurities.

Formation-Heat of Chloral Hydrate: a Reply to M. Berthelot.—A. Wurtz.—The author endeavours to uphold the accuracy of his experiments, which M. Berthelot had called in question.

An Application of the Pre-existence of Ampère's Currents in Soft Iron.—M. Trève.—In a former communication the author has shown that if currents of equal intensity are caused to circulate in coils of copper and of iron, we obtain in the latter a polarity which—according to the quality of the iron employed—may be four times as great as in the diamagnetic coils. The author has subsequently applied this remarkable property to apparatus for demonstrating the action of currents and the directing action of the earth upon solenoids.

On New Luminous Tubes.—M. Trève.—The author introduced a Fizeau condenser into a large Geissler tube. The two poles of the induced current of a Ruhmkorff coil were placed in contact with this condenser by means of the ordinary electrodes of such tubes. When the induced current is passed into the condenser, the tube still containing air at the atmospheric pressure, the ordinary snorting sound is heard, which gradually becomes fainter as the vacuum is made. When the pressure is reduced to 0·004 m. nothing is heard, but there appears a white and brilliant light, absolutely distinct from the pale, vague, phosphorescent light of Geissler tubes.

Action of Acetic Anhydride upon certain Phenol Aldehyds.—P. Barbier.—This paper does not admit of useful abstraction.

A New Synthesis of Saligenin.—W. H. Greene.—Saligenin, being oxybenzylic alcohol, is formed by the reaction of methylen chloride upon sodic phenate in presence of sodium hydrate. The yield is somewhat larger if the soda is dissolved in alcohol.

Preparation of the Iodine and Bromine Derivatives of Benzin.—W. H. Greene.—Chloride of iodine reacts upon benzin in presence of aluminium chloride, disengaging hydrochloric acid and forming iodised derivatives of benzin. The best method of operating is to let fall the chloride of iodine, drop by drop, into benzin containing a little aluminium chloride. The product is washed with potassa, and the phenyl iodide isolated by fractionated distillation. Higher iodised benzines are obtained in the same manner, and if the mono-compound is required a large excess of benzin must be employed. The bromine derivatives may be easily obtained by heating a mixture of bromine and benzin in presence of aluminium chloride.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 2, January 8, 1880.

"Electricity Tommasi."—Under this title there is an essay of nine pages in favour of the battery of Dr. Tommasi and its application to the production of the electric light. The paper professes to be a reply to an article by M. Delahaye.

Application of the Tommasi Battery.—M. Bourrières.—The author proposes to arrange a number of

Rhumkorff coils for quantity as in Nollet's magneto-electric machine, substituting for the motive power the Tommasi battery.

Electricity of Cats.—M. Pallas.—The author on stroking a cat experienced formal electric shock. His right hand rested on the left shoulder of the animal whilst he stroked her back with his left. The shocks were felt in the right hand on ceasing to touch her with the left.

MISCELLANEOUS.

Society of Arts.—The Section of the Society of Arts, formed in 1874, for the discussion of subjects connected with Practical Chemistry and its application to the Arts and Manufactures, has been this year enlarged in its scope that it may include Application of Physics as well as of Chemistry. At the meetings of the present year the following papers will be read:—February 12, "Gas Furnaces and Kilns for Burning Pottery," by Herbert Guthrie, C.E.; March 11, "The Noxious Gases Bill," by E. K. Muspratt, F.C.S.; April 8, "On Recent Improvements in Benzine Colours," by F. J. Friswell, F.C.S.; April 22, "On some Recent Advances in the Science of Photography," by Captain Abney, R.E., F.R.S.; May 13, "On some Physical Applications of Light," by Prof. W. G. Adams, F.R.S. The meetings are on Thursday evenings, at 8 o'clock, and the days have been selected so that they do not clash with those on which the meetings of the Chemical Society are held.

NOTES AND QUERIES.

Schaffner's Glass Reaction Wheel.—Can any reader tell English sulphuric acid makers whether Schaffner's small glass reaction wheel or Barker's mill (mentioned on p. 385 of Lunge's work "Sulphuric Acid and Alkali"), for distributing the acid over the Glover and Gay-Lussac towers, can be purchased in this country? The heavy lead ones in common use are very liable to stop revolving, and thus to seriously derange the working of the towers.—ONE.

TO CORRESPONDENTS.

S. Sankey.—Reimann's "Aniline and its Derivatives," published by Longmans, may be seen at the British Museum Library.

H. C. Standage.—Declined with thanks.

Dr. Kemshead.—Full references will be found in the indexes.

G. Valentine.—Not suitable for "Notes and Queries." Should be an advertisement.

MEETINGS FOR THE WEEK.

MONDAY, 2nd.—London Institution, 5.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Arts, 8. "The Manufacture of India-rubber and Gutta-percha," by Thomas Bolas, F.C.S.
TUESDAY, 3rd.—Royal Institution, 3. Prof. Schäfer, "Physiology of Muscle."
—— Civil Engineers, 8.
—— Zoological 8.30.
—— Society of Arts, 8. "Social and Commercial Prospects in the Transvaal," by the Rev. G. Blencowe.
WEDNESDAY, 4th.—Society of Arts, 8. Ordinary Meeting.—"Trade and Commerce with Siberia via the Kara Sea," by Henry Seebohm.
—— Geological, 8.
Pharmaceutical, 8.
THURSDAY 5th.—Royal Institution, 3. Prof. Dewar, "Chemical Progress."
—— Royal, 8.30.
—— Chemical, 8. "Contributions from the Laboratory of the University of Tokio, Japan:—On Persulphocyanate of Silver," by R. W. Atkinson. "On Methylated Dioxethylen Amines," by H. F. Morley.
—— Royal Society Club, 6.30.
FRIDAY, 6th.—Royal Institution, 8. Dr. Huggins, "Photographic Spectra of Stars," 9.
—— Geologists' Association, 8.
SATURDAY, 7th.—Royal Institution, 3. Prof. Pau[illegible], Hai[illegible]el."

AMMONIACAL LIQUOR.

The Newest and Best Continuous Method for working large or small quantities of liquor. This method is an improvement on what is known as the "Coffey Still Process." The cost of plant is very much less than by the above process. It is also much more durable. The result in sulphate of ammonia is very large, every atom of ammonia gas being driven out of the liquor before it is liberated. *Small Working Models* to work about *Five Gallons per Day*, with every requisite, including steam boiler, &c., for working any ordinary gas liquor. Sent C.O.D., with instructions, price £4 4s. Price for erecting, or for plans and specifications of large plant on application.

JOHN G. HARVEY,
Ethel Terrace, Milnsbridge, Huddersfield.

TO SULPHATE OR MURIATE OF AMMONIA MAKERS AND OTHERS.

The Combustion of Sulphuretted Hydrogen, and its manufacture into Oil of Vitriol.

This apparatus has been successfully working or a series of years at the Chemical Works, Frizinghall, nr. Bradford (Messrs. Hunt and Illingworth's), the perfecting of which was the result of an incalculable amount of study on the part of the proprietors.

It is necessary, for the thorough and efficient working of the Plant to adopt as well their improved Plant for making Sulphate or Muriate of Ammonia.

The undersigned are open to treat with any person wishful to adopt the process:—

The executors of the late Mr. Wm. Hunt, Messrs. HUNT and GORLE, at the Chemical Works Wednesbury, Staffordshire;
Or Mr. THOS. ILLINGWORTH, Ilkley, Yorkshire.

ESTABLISHED 1798.

ROBERT DAGLISH & CO.,
ENGINEERS, BOILER AND BRIDGE MAKERS, MILLWRIGHTS,
BRASS AND IRON FOUNDERS.

Manufacturers of every description of Condensing, or High-pressure Blowing, Pumping, Rolling, Winding, and Patent Steam-engines, of any required power, for Irrigating, Draining, Mining, Rolling Mills, or Water Works purposes, and Manufacturers of every description of Chemical, Colliery, Copper Ore, Gold Mining, Glass, and Rock-salt Machinery.

Black-ash Revolving Furnaces of the Most Approved Type.
Bessemer Steel-Rail Plant.
Compressing-Engines for Collieries, Iron Works, and Weldon's Patent Bleaching-Powder Process.
Caustic, Chlorate, Decomposing, Nitre, Nitro-Glycerine, Iodine, Potash, Sulphur, Acid, and Oxalic Pans.
Gas Producers Patent for Heating and other Purposes.
Pyrites Burners for Irish, Norwegian, and Spanish Ores of Improved Construction.
Patent Rousing Machinery for Brewers.
Retorts, Acid, Gas, Iodine, Nitric, Nitre, Nitro-Glycerine, and Vitriol Refining.
Steam Superheaters improved for Oil, Tar, and Resin Refining.
Steam Sulphur Melter.
Stills for Oil, Resin, and Tar.
Wheels, Bevel, Mitre, and Spur Moulded on the Shortest Notice by Patent Machinery.

Makers of Mactear's Patent Carbonating Furnace, Jones and Walsh's Patent Sulphate of Soda Furnace, Parnell and Simpson's Patent Causticiser, and Kynaston's Patent Alum Plant.

Lists sent on Application.

Photographs, Plans, and other information supplied on receipt of Order.

ST. HELEN'S ENGINE, BOILER, AND BRIDGE WORKS AND FOUNDRY,
LANCASHIRE.

POLYTECHNIC.—MARY QUEEN OF SCOTS.—The principal events in the life of the beautiful and unfortunate Mary Stuart, illustrated by Tableaux Vivants. The descriptive poem recited by Miss Alice Burnelle. The appropriate vocal music by a Choir of Glee Singers, under the direction of Mr. Stedman, daily at 3.30 and 8.30; Edison's Loud Speaking Telephone, &c., by Mr. Daniel, 10.30; the Zulu War and the Heliograph, by Mr. King, 11; London as it Was and Is, 11.30 and 8; the Electric Light, 12; Instrumental Concert by the Paggi Family, 2.30 and 7.30; Popular Optical Lecture, 3, by Mr. King: Phenomena of Light and the Ghost; by Mr. King, 6.30. Open 10 till 1, 2 till 5, and 6 till 10. Admission 1s. Reserved Seats, 2s., 1s., and 6d.

GREENBANK ALKALI WORKS COMPANY (LIMITED), ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{2}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application. Orders for small quantities executed for Cash against Invoice.

NEWTON, KEATES, & CO., Sutton Oak Manure Works, ST. HELENS LANCASHIRE,

MANUFACTURERS OF

PHOSPHATE OF SODA.

DAHL & CO., BARMEN (RHENISH PRUSSIA),

MANUFACTURERS OF

ANILINE AND NAPHTHALINE COLOURS.

PECIALITY—Ponceau Naphthol-Reds as a Substitute for Cochineal.

Sole Agency and Depôt in England,

THEODOR BANG,

BENSON'S BUILDINGS, BASINGHALL ST., LEEDS.

THOMAS ADKINS & CO., SMETHWICK, NEAR BIRMINGHAM

MANUFACTURERS OF SPECIALLY PREPARED RED LEAD FOR FLINT-GLASS MAKING.

WILLIAM AND WILLIAM T. FIELD,

MANUFACTURERS of the Celebrated STAFFORDSHIRE BLUE BRICKS, specially adapted for Chemical Plant, *i.e.*, Acid Towers, &c. Also all other kinds of Best Staffordshire Blue Bricks, Pavings, Plynths, Splays, Copings, &c. &c. Prices and samples on Application.

TESTIMONIAL.

"We have used the Blue Staffordshire Brick for Sulphuric Acid Towers, &c., manufactured by Messrs. Field, for the last fifteen years, during which time they have given great satisfaction. We recommend them to the Chemical Trade, believing there is nothing better in the market."—(Signed) WILLIAM HUNT and SONS, Lea Brook Alkali Works, near Wednesbury, Staffordshire, February, 1878.

TOLL END BRICK-WORKS, TIPTON, STAFFORDSHIRE.

TOWNSON & MERCER, 89, Bishopsgate Street Within, LONDON.

Wholesale and Export Dealers nd Manufacturers of

CHEMICAL & SCIENTIFIC APPARATUS

PURE CHEMICALS, &c.,

For Analysis and the general Laboratory Use of Manufacturers and Professors of Universities, Schools, Mines, &c.

Now ready,

TOWNSON & MERCER'S COMPLETE CATALOGUE of Chemical and Scientific Instruments, Pure Chemicals &c. Demy 8vo. Illustrated with upwards of 800 Woodcuts. Price 2s. post free.

S. A. SADLER, CLEVELAND CHEMICAL WORKS, MIDDLESBROUGH

Newfall Tar Works, Carlton; Ammonia Works, Stockton-on-Tees; and Stamshaw Chemical Works, Portsmouth.

And also of the Furness Tar Products Co., Ulverston.

Manufacturer of Benzole, Toluole, Xylol, Solvent and Burning Naphthas, Carbolic Acid and Disinfecting Powder, Refined Anthracene, Napnthaline, Black Varnish, Refined Tar, Crude Liquid Ammonia, Coal-Tar, Pitch, Creosote, Grease, Sulphate of Ammonia, Pyroligneous Acid, Acetate of Lime, Wood Naphtha, Charcoal, &c., &c.

S. A. S. is always a buyer of Coal-Tar Naphthas, Crude Anthracene and all Tar Products.

All communications to be addressed to the offices at Middlesbrough.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

THE SPRENGEL AIR-PUMP.

GIMINGHAM'S IMPROVED.

WITH MULTIPLE FALL-TUBES and every recent improvement, including McLeod's Gauge, Barometer Gauge, Radiometer, terminals for testing non-conductivity of the vacuum, &c., &c.

L. Casella having arranged with Mr Gimingham for the sole manufacture of these pumps is prepared to supply them either in their simple form or with all or any of the accessories. Mr. Gimingham has engaged to examine each instrument, in order that no imperfect instrument may be sent away.

CROOKES'S RADIANT MATTER TUBES.—L. Casella has also the pleasure of stating that he is now able to supply the highly exhausted tubes illustrating Mr. Crookes's beautiful experiments on Radiant Matter, and guarantee their excellence, as each will be sent to Mr. Gimingham for examination before going out.

L. CASELLA, 147, HOLBORN BARS, LONDON, E.C.

THE CHEMICAL NEWS.

VOL. XLI. No. 1054.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 50.)

TURNING to lanthanum and didymium, we find that only the latter gives, independently of its ordinary oxide, a brown-chocolate coloured peroxide, decomposed by heat, not answering to any determined formula, and not furnishing any salts. For this reason we cannot settle the atomic weights of lanthanum and didymium, except from observations on the salts of the ordinary oxides, whose equivalents are very nearly alike (about 46). Again, we cannot be sure of the correctness of these last numbers, above all in the case of didymium, because we have no means of distinguishing a mixture of lanthanum, yttrium, and perhaps even thallium and erbium, from the salts of didymium. According to their equivalents, which are very close together, lanthanum and didymium can occupy one of three places in the system. First, in group III., series 8, between Ba=137, at Ce=140? In this case the calculated equivalent is—

$$44{\cdot}5 = \frac{138}{3}$$

which corresponds with the observed figures. It is very easy, however, to admit an error in the determinations, as the purity of the preparations is only guaranteed by repeated crystallisations, which we well know do not always free us from isomorphous impurities.

The place, "Group III., Series 8," corresponds, according to the atomic analogy, with Cs, Ba, and Ce, to an element which has very basic properties, and which forms very difficultly volatile chlorides; lanthanum and didymium have certainly properties of this kind.

The second place, in which these properties of the oxide would put La and Di, is "Group IV., Series 10," before Ta=182, in atomic analogy with Ce=140 (?) and Th=231. The element which would fill this place should have an atomic weight of about 180, an equivalent 45, corresponding to the oxide RO_2, and nearly identical with the equivalent of La and Di (above all of La).

A third place is free "Group V., Series 12," between Th=231 and Ur=240, for an element which gives an oxide, R_2O_5, and which has an atomic weight of about 235, and an equivalent of about 49. It would be difficult for one of these two metals to occupy this place; the equivalent is too high and the oxide should possess feebly basic properties, less pronounced than in ThO_2, and more so than in UrO_3; the oxides of La and Di present, on the contrary, very strongly marked basic properties, and they are soluble in dilute acids, even after calcination. The oxides and the metals which would suit this place ought, like their atomanalogues, to have a great density, whilst the densities of the oxides of La and Di are about 6·5. I therefore think that I am authorised in admitting that La and Di should occupy the two first-named places, that is to say that the oxide of one of these metals possesses the composition R_2O_3, and corresponds to the lower oxide of Ce, and that the oxide of the other is of the form RO_2, and corresponds to the higher oxide of cerium.

The following facts bear witness to the difference of composition of the oxides of La and Di; according to information received personally, Marignac has not noticed one single case of isomorphism between the corresponding salts of La and Di. In one solution Watts obtained different crystals of sulphates of La and of Di. Marignac found that the sulphates had different compositions. If we admit the formula RO for the two oxides, sulphate of didymium is $3DiSO_4,8H_2O$, and sulphate of lanthanum is $LaSO_4,3H_2O$. We have already noticed that the formula R_2O_3 corresponds better to oxide of didymium than it does to oxide of lanthanum, because it changes the unusual formula, $3DiSO_4,8H_2O$, of sulphate of didymium into $Di_2(SO_4)_3$. Further, if we represent oxide of lanthanum by LaO_2, the composition of sulphate of lanthanum will be $La(SO_4)_2,6H_2O$. If we consider that we often meet in nature with oxides of different compositions together, such as Nb_2O_3 and TiO_2 (Marignac, Hermann), WO_3 and Nb_2O_5 (Wöhler), V_2O_5 and CrO_3, then the simultaneous appearance of Ce_2O_3, Di_2O_3, and LaO_2, should not surprise us, as it is by no means an isolated fact; it might be compared to the concomitance of ZnO, CdO, and In_2O_3.

For these reasons we can admit that the atomic weight of Di=138, that the metal belongs to the third group, and that it forms an oxide, Di_2O_3; and, on the other hand, that lanthanum belongs to the fourth group, and possesses the atomic weight 180*, the formula of the oxide being LaO_2. However, we cannot be certain of the exactitude of these hypotheses except after new researches in this direction. Up to the present we only know a small number of facts, and we have even interpreted these facts, admitting the formula of the oxides to be RO. The study of the compounds of these metals would present a new interest, because of the modifications that would be introduced in the formulæ of the oxides.

To show how these modifications that I propose to introduce will appear, I extract from Marignac's work the formulæ of several salts of didymium, and I put opposite them the formulæ modified by the new atomic weight; we shall see that these latter are more reasonable.

	According to the Ordinary Atomic Weight.	According to the New Atomic Weight.
The Oxide ..	DiO;	Di_2O_3.
,, Hydrate ..	$Di(OH)_2$;	$Di(OH_3)$.
,, Oxysulphide	$DiS,2DiO$;	Di_2O_2S.
,, Chloride ..	$DiCl_2,4H_2O$;	$DiCl_3,6H_2O(Di_2Cl_6)$.
,, Oxychloride	$DiCl_2,2DiO,3H_2O$;	$Di_2Cl_2O_2,3H_2O$.
,, Phosphate	$Di_3(PO_4)_2,2H_2O$;	$DiPO_4H_2O$.
,, Sulphate	$3DiSO_4,8H_2O$;	$Di_2(SO_4)_3,8H_2O$.
,, Sulphate	$DiSO_4,2H_2O$;	$Di_3(SO_4)_3,6H_2O$.
,, Basic salt	$DiSO_4,2DiO$;	$Di_2O_2(SO_4)$.
Double salts	$3(DiSO_4)Am_2SO_4,8H_2O$;	$DiAm(SO_4)_2,4H_2O$.
	$3(DiSO_4)Na_2SO_4$;	$DiNa(SO_4)_2$.
	$3(DiSO_4)K_2SO_4,2H_2O$;	$DiK(SO_4)_2H_2O$.

The last three salts are of the same composition as alum, except the small quantity of water they contain. Oxide of didymium, as well as alumina, has the property of being precipitated, although slowly, from its solutions by means of carbonate of barium. The analogy between Di_2O_3 (modified formula) and Al_2O_3 was shown in the last vertical column. If the basic properties of Di_2O_3 are more strongly marked than those of Al_2O_3, we can explain it according to the periodic law by this circumstance, that didymium belongs to one of the even and higher series, whilst aluminium belongs to an odd and lower series.

The composition of the salts of LaO_2 is, according to all that we know, more simple than the composition of the salts of didymium, and it corresponds to the proposed modification of the atomic weight; to $LaCl_4$, for example (or, perhaps, La_2Cl_8, as it is not volatile), corresponds an oxychloride, $La_2O_3Cl_2$. If the formulæ which we give to CeO_2 and LaO_2 are exact, then the salts which correspond to them will turn out to be isomorphous, and will also be

* It is now possible to obtain lanthanum free from didymium if we guide ourselves by the absorption spectra of the didymium salts, which spectrum was first observed by Gladstone. The numbers found by Zschiesche (45·09), Rammelsberg (44·38), and Erk (45·1) correspond very well to La, because, according to them, La ought to equal 180·36, 177·52, or 180·4.

analogous to the salts of Th and Zr. The study of the double salts of ZrO_2, CeO_2, LaO_2, and ThO_2 would offer a particular interest, as these oxides often form well-crystallised double salts. If the proposed formulæ are correct we might venture to predict the formation of salts as characteristic as the alums. I have already commenced several experiments in this direction.

(To be continued.)

AN EXAMINATION OF SOME COUNTY DUBLIN WATERS.

By J. FLETCHER, F.C.S.,
Membre de la Société Chimique de Paris, Fellow der Deutschen Chemischen Gesellschaft.

The following examinations of waters from certain districts in the vicinity of Dublin, made during an autumn vacation, may possess interest for those who make potable waters their study, comprising as they do samples from limestone, granitic, clay, and sea-shore gathering grounds.

For the purpose of comparison I have followed Dr. Tidy's plan of leaving the sample in contact with standard solution of potassium permanganate for three hours, and noting the oxygen consumed: this will enable the reader to compare the results with an average of Tidy's monthly reports of London waters. In following this method I do not adopt it as the best, but for the purpose of comparison only. I believe that a really reliable mode of estimating the organic contamination of drinking water has yet to be discovered: the translation of Tiemann and Preusse's article which is contained in your last issue is a valuable contribution to the literature of the subject, as is also their article upon analysis of gases contained in water, which appears in the same number of the *Berichte der Deutschen Chemischen Gesellschaft*.

Vartry Water.—My experiments with this water having already been given in the Chemical News (vol. xl., p. 171) I will not further occupy your space with them.

Rathmines Township.—The City of Dublin, until the Vartry system was established, drew its supplies from the canals. The large and populous township of Rathmines is still supplied from the same source, as are all the great breweries and distilleries: a process of filtration of an imperfect character is gone through, which has only the effect of reducing in a small degree the amount of organic matter, but does not remove it effectually, merely retaining a portion of the matter held in suspension. The mean of several samples taken from different points on the open canal, compared with the average of those from a public fountain in the Rathmines Commissioners Yard, show the results of this partial treatment:—

	Unfiltered.	Filtered.
Total solids..	42·000	26·000
Chlorine	1·280	1·278
Hardness before boiling ..	12°	12°
Hardness after boiling ..	8°	9°
Oxygen consumed	0·120	0·100

In grains per gallon and measures soap solution.

Howth is a very important fishing station,—a favourite port of the Manx and Cornish herring fleets,—and is also a fashionable summer resort of the Dublin mercantile classes: it is a picturesque peninsular hill of limestone, forming the northern boundary of the bay, and about 9 miles from the city. During the season the harbour contains fully a thousand boats, with crews of five men each; the fish-curer's factories and workmen make altogether a season's population of about 6000, in addition to the regular inhabitants. The water-supply to the harbour is therefore an important matter, and its source is certainly peculiar and suggestive. Overhanging the harbour is a ruined abbey, and burial-ground of the monks, the local gentry, and townspeople, still used: from out the wall of the abbey grounds, and several feet below the level of the graves, two pipes project from which flow streams, one of which supplies a public fountain, and is then led through pipes along the pier for the use of the boats. I have seen quite a number of water-casks being filled directly from the pipes. I have made a great many enquiries, and the conclusion I have come to is that the two streams are the drainage waters of the hill upon which the abbey and part of the town are built, supplemented perhaps by other surface waters, but that they contain the soluble constituents of a long succession of buried townsfolk; both consume a large quantity of oxygen, and in one the proportion of chlorine is considerable. I have added the examination of two other sources of supply to other parts of the place not used by fishermen,—the "Forge Well," being on very high ground and used by poor cottiers, and the well at Lord Howth's baths; the latter, being within 10 feet of high-water mark, should show considerable chlorine contamination, but it is far excelled by the churchyard water.

	Churchyard No 1.	Churchyard No. 2.	Forge Well.	Bath Well.
Total solids.. ..	32·000	51·000	70·000	72·000
Chlorine	3·124	6·993	2·378	3·017
Oxygen used ..	0·220	0·130	0·100	0·100
Hardness before boiling	20°	22°	17°	17°
" after boiling	16°	17°	16°	16°

In grains per gallon and measures soap solution.

Malahide is a pretty little town on the shores of the Irish Channel: it is built at the edge of a limestone formation, on sandy knolls, and is surrounded by dunes which put the visitor in mind of Schweningen and the Dutch coast generally. It is a summer resort, and the people in a great measure live by letting furnished lodgings. It boasts of a splendid hotel, built and owned by Lord Talbot de Malahide. There is no public water-supply, the inhabitants depending upon the collection of rain-water and pumps. The hotel pump yields a water of the most sparkling clearness, and the coolest and freshest flavour imaginable; but it will be seen that the solids and chlorine are exceedingly high: the oxygen used, however, is small in amount, differing in this respect from a public pump situated upon the strand, which not only shows a large solid residue and chlorine, but a very large consumption of oxygen. The poorer classes, however, are supplied from a well in what is called the Old Main Street, which is better than either of the others, but still bad enough. There should certainly be something done to improve the supply to this place. The following are the data:—

	Hotel.	Strand Pump.	Street Well.
Total solids	67·000	90·000	40·000
Chlorine	9·445	6·465	3·550
Oxygen	0·010	0·180	0·060
Hardness before boiling..	14°	18°	19°
" after boiling ..	9°	18°	12°

In grains per gallon and measures soap solution.

Dalkey is a bold and rugged granite mountain forming the southern boundary of Dublin Bay, and opposite to the limestone headland of Howth. It contains a town of some 3000 inhabitants, and is thickly studded with handsome and expensively built villas belonging to Dublin merchants: it is abundantly supplied from the Vartry Reservoir, but until late years was dependent upon wells. I examined two only, and the results were disappointing. I expected different and better results, as the geological formation is entirely granitic. It may be explained by one of the wells being under a pump in the town, surrounded by garden patches and dairy yards; the other, called Our Lady's Well, is situated in a cave within a few yards of the sea, amidst rocks, in the grounds of the

Catholic Convent, and has a local reputation for curative properties :—

	Total Solids.	Chlorine.	Oxygen.	Hardness before Boiling.	Hardness after Boiling.
Tobermore Well	50	2·520	0	25°	14°
Lady Well ..	49	3·727	0	19	19

It will be seen that all the samples examined show very great hardness, a large proportion of total solids, and chlorine. For convenience of comparison I tabulate them :—

	Total Solids.	Chlorine.	Hardness before Boiling.	Hardness after Boiling.	Oxygen consumed.
Average of eight London Co.'s	22	1·257	14·56	4·36	0·079
Unfiltered Canal Water	42	1·280	12	8	0·120
Filtered ditto, Rathmines ..	26	1·278	12	9	0·100
Howth, Churchyard No. 1 ..	32	3·124	20	16	0·220
Ditto, No. 2 ..	51	6·993	22	17	0·130
Forge Well, H'th	70	2·378	17	16	0·100
Well at Lord Howth's Baths	72	3·017	17	16	0·100
Malahide Hotel	67	9·445	14	9	0·010
Do. Strand Pump	90	6·465	18	18	0·180
Do. Street Well	40	3·550	19	12	0·060
Dalkey, Tobermore Well ..	50	2 520	25	14	None
Ditto, The Lady Well	49	3·727	19	19	None

NOTES ON THE ALKALOIDS.

By T. TATTERSALL.

1. *Delphinine.*—In addition to the ordinary tests for this alkaloid, the following is exceedingly trustworthy and characteristic :—Take a small quantity, and triturate intimately in a porcelain basin with 1 to 2 times its bulk of malic acid. Now mix with half a dozen drops of concentrated sulphuric acid, and once more stir round with a small agate pestle, to render the liquid perfectly homogeneous. The orange colour first obtained becomes rose-red : this acquires intensity on standing, and after several hours has attained its maximum shade—a beautiful dark rose-colour, with a very slight violet halo round the edge. A gradual transition to a bluish violet takes place : this persists some time, but finally becomes a dirty cobalt. The colour obtained in the first instance is not produced by these reagents on the other alkaloids, and is quite different from that produced by sulphuric acid alone, which is a light Indian red. The change from rose to violet is also peculiar, only care must be taken to add a sufficiency of sulphuric acid, otherwise this may not be observed. The experiment also fails if the alkaloid be first dissolved in the acid, and the malic acid afterwards added; nor should the liquid be heated, or carbonisation of the organic acid will ensue. Citric, tartaric, benzoic, succinic, and tannic acids do not manifest this reaction.

2. *Morphine.*—If mixed with concentrated H_2SO_4 and a crystal of Na_3AsO_4, gives first a dirty violet colour, becoming on heating dark sea-green, when acid vapours escape ; a rather fugitive dark grey colour appears.

Papaverine and *Codeine* also give characteristic colours with these reagents (See CHEMICAL NEWS. vol. xl., p. 126).

Hayfield Printing Co., Hayfield.

Thomson's Galvanometer.—A. Gaiffe.—The author has introduced an improvement in the method of suspension, making use of two cocoon threads very near to each other. He thus reduces the error to less than 1-100th of the value measured.—*Comptes Rendus.*

ON THE TANNIC ACID OF SUMACH LEAVES.

By H. MACAGNO,
Director of Agricultural Stations.

DURING 1879 I undertook some researches on the production of tannic acid in the leaves of sumach (cultivated in Sicily) by the Flek and Simpkin improved process. In decoctions of sumach tannin may be separated by precipitation with an ammoniacal solution of copper. Take 10 c.c. of a decoction of sumach, acidify with sulphuric acid, add some water, and titrate with permanganate of potash. From 100 c.c. of the same tannin extract precipitate the tannic acid with ammoniacal acetate of copper, taking care that there is an excess of ammonia, and filter. The first few drops of filtrate are rejected, and then 10 c.c. of the filtrate are to be acidified with sulphuric acid, diluted, and titrated with permanganate. The number of cubic centimetres of permanganate destroyed by the solution, from which the tannin has been separated, subtracted from that required before removal of the tannin, gives the quantity of permanganate which has been required to oxidise the tannic acid. The analyses were made separately on the leaves of the lower and superior sides of branches, and the results per cent are as follows :—

	Water in Leaves.		Tannin in Leaves.		Mean Results.	
	Superior Side.	Lower Side.	Superior Side.	Lower Side.	Water.	Tannin.
June 10, 1879 ..	58·15	60·23	24·93	17·45	59·19	21·19
„ 16 „ ..	57·12	63·40	24·92	16·11	60·30	20·51
„ 27 „ ..	52·47	63·44	25·82	15·27	57·95	20·54
July 14 „ ..	51·15	62·24	24·75	10·81	56·69	17·78
„ 29 „ ..	49·80	60·33	23·80	9·44	55·06	16·62
Aug. 11 „ ..	48·15	61·80	21·91	8·77	54·97	15·34

An unknown and interesting fact shown by these results is the greater quantity of tannin in the leaves of the superior side of branches, and also the total decrease of this element with the growth of sumach. Notwithstanding, for commercial purposes, the cultivator will be always led to retard the crop, as the extra quantity of leaves compensates for the want of tannic acid.

Palermo, Italy, January, 1880.

CUPRIC TEST-PELLETS FOR SUGAR.

AT a meeting of the Clinical Society, on the 23rd ult., Dr. Pavy said that he desired to introduce to the notice of the members a new form of test for sugar, which he thought would prove of no inconsiderable service to the medical practitioners. Of the various reagents that have been recommended for the detection of sugar, his experience led him to consider the cupric test by far the most reliable, and this view stood in accord with that which was generally entertained by analytical chemists. It had been hitherto the practice, certainly where delicacy and precision were in question, to employ the test in the form of a solution prepared by mixing an alkaline tartrate with sulphate of copper and either potash or soda. Such a solution contains the oxide of copper in a state ready to be reduced to the condition of the suboxide when in contact at a boiling temperature with glucose. When freshly prepared this solution fulfils all that can be desired, but there is the disadvantage belonging to it that after being kept for some time, especially if exposed to light and air, it is liable, without the presence of sugar, to throw down a certain amount of reduced oxide on boiling, and thus possibly to mislead unless precautions are taken to provide against it. Besides this objection, the liquid, unless frequently used, is very apt to cause the stopper of the bottle in which it is kept to become fixed. In fact it must be spoken of as an inconvenient liquid to keep for only occasional use.

Dr. Pavy had long felt that it would be very desirable if the ingredients of the test could be incorporated and kept in a solid form; and some years ago a fruitless attempt was made to attain this object. Latterly he had given his attention afresh to this subject, and the test-pellets before the Society were the result of the task undertaken. He need not enter into details regarding the ideas which failed on application to yield a satisfactory result. It would suffice for him to say that the test-pellets contained the solid ingredients of the cupric test solution in a dry state, and that they were brought into the condition of a coherent mass by compression. The preparation had been placed in the hands of Mr. Cooper, of 26, Oxford Street, who, it was but justice to say, most successfully met the difficulties that were unexpectedly encountered. An article had been produced which met with Dr. Pavy's entire satisfaction, and which he felt was adapted hereafter to render good service in relation to diabetes. There appeared no reason why the pellets should not keep for an indefinite time, without undergoing change, if preserved in a closed bottle away from moisture. In using them all that was necessary was to place one in a test-tube with about 3 c.c.—or rather under a drachm—of water, and to apply heat until complete solution had occurred, with the accomplishment of which a clear deep blue liquid would be formed, which actually constituted the cupric test solution. At present it was only as a qualitative test that the pellets were introduced, but there was no reason that hereafter the preparations should not be conducted with sufficient attention to accuracy of weighing to render them applicable for quantitative analysis. Dr. Pavy further mentioned that the test-pellets exhibited were ready to be sold by Mr. Cooper, in bottles containing twenty-four, at a cost of one shilling.

ON THE

DETERIORATION OF LIBRARY BINDINGS.*

By Prof. WM. RIPLEY NICHOLS,
Of the Massachusetts Institute of Technology.

Some time since a librarian of my acquaintance brought to me the backs of a number of books, the leather of which had, in some instances, deteriorated to such an extent as to readily crumble to a brown powder when scratched lightly, as with a finger nail. My opinion was asked as to the part that coal-gas or the products of its combustion played in the destruction of the leather.

I confess that I had supposed the matter settled long since, having in memory a discussion in the English journals of some ten years ago. When I found, however, that a chemist as eminent as Dr. Wolcott Gibbs doubted the influence of coal-gas in the matter, I felt that there was room for further investigation. Although I have not done as yet all that I should like to do, or indeed all that I expect to do in the matter, I desire to state the results which I have obtained in the hope that there may be others here who can throw some light upon the subject.

I may first recall what has been done by others. As long ago as 1854, Dr. Letheby made a report to the City authorities of London, in which he took the ground, which he afterwards on other occasions maintained, that the destruction of bindings in libraries and the destruction of textile fabrics in warehouses, where gas was burned continuously and in large quantities, was due to the products of the combustion of imperfectly purified gas. He noticed that the water produced by burning gas is always acid, and will rot leather, paper, cotton, and linen.

Dr. Odling, in a lecture before the British Association of Gas Managers, June, 1868, maintains that the amount† of sulphur in coal-gas is of no great consequence, and shows by mathematical calculation that the amount of sulphuric acid formed is extremely small compared with the amount of air through which it is diffused. In spite of this, every chemist knows that sulphuric acid is formed when coal-gas is burned, and that articles of galvanised iron or of zinc, when exposed to the lamp-flame, become corroded with formation of sulphate of zinc. This fact is noted with some quantitative statements by Mr. Charles Heisch, F.C.S., Superintending Gas Examiner to the Corporation of the City of London.* From a burner consuming one-half a foot per hour, the products of combustion of which passed into a zinc chimney, he collected in six weeks three-quarters of a pound of sulphate of zinc.

In the Chemical News for 1877, vol. xxvi., p. 179, Prof. A. H. Church states that he found in decayed leather from the backs of books which had been on the upper shelves of an apartment lighted by gas—

Free sulphuric acid	6·21 per cent
Combined sulphuric acid ..	2·21 ,,

He accepts without hesitation the theory that the decay is due to the sulphuric acid formed by the combustion of the gas. In the same volume of the Chemical News there is a paper on the subject by Mr. George E. Davis, who examined the leather of some books which had been in daily use in a large office in Manchester from 1855-1858; after that time till August, 1877, they remained uncovered on a shelf near the ceiling of the same room. The books had been strongly bound in rough calf, and had red basil lettering pieces. Upon knocking the books the leather of the backs came off as a mixture of dust and small pieces, which was very acid to test-paper. The leather from the back was treated with water, and the aqueous solution found to contain:—

	Per cent by weight of leather taken.
Combined sulphuric acid	2·847
Free ,, ,, ...	1·920

The leather underneath the lettering piece contained:—

Combined sulphuric acid ..	0·39 per cent
Free ,, ,, ..	0·76 ,,

The red basil lettering piece contained:—

Ammonia	1·28 per cent
Combined sulphuric acid ..	0·87 ,,
Free ,, ,, ..	1·04 ,,

In 1878 Dr. Gibbs examined books in the Boston Public Library, in the Boston Athenæum, in the Harvard College Library, and in the Astor Library in New York City—in some of which gas is used and in others not. He arrived at the conclusion† "that there was no sufficient evidence" that the products of the combustion of coal-gas caused the trouble, and seemed inclined to consider the fault to lie in the tanning of the leather. He says, "I analysed a number of samples of the leather in my own laboratory and find no free acid whatever."

My own experience is as follows:—I have had a large number of samples of leather in all stages of decay. I found, as others have done, that *morocco* is but little affected, while Russia and calf are badly acted upon, and ordinary sheep is also attacked. Qualitative and quantitative examinations showed that, in a general way, the more the leather was decayed the more marked was the acid taste and acid reaction on test-papers, and the larger was the amount of sulphuric acid to be found in the aqueous extract. Further, I found that the aqueous extract always contained ammonia, and although the solution had an acid reaction and required a certain quantity of alkali to neutralise it, in no instance, I think, was the acid in greater quantity than that which would be required for the *acid* sulphate of ammonium. I examined a number of samples of fresh leather; the aqueous extracts were only slightly acid, not sufficiently so to affect the taste, and

* Read at the Saratoga meeting of the American Association for the Advancement of Science, August, 1879.

† Chemical News," vol. xxiii. (1868), p. 65.

* London *Journal of Gas Lighting*, 1874, p. 856.

† In a letter to W. W. Greenough, Esq., dated Aug. 5, 1878, and published in the *Lib. Jour.*, vol. 3, p. 229.

contained only a minute amount of sulphuric acid in combination.

I will now give some of the results of quantitative analyses which have been made in my laboratory. The method employed was to soak the leather with successive portions of water until chloride of barium ceased to produce a precipitate, using at first, at any rate, a temperature less than that at which the leather balls together. A portion of the extract was acidulated with chlorhydric acid, and the sulphuric acid precipitated as sulphate of barium. Another portion was distilled with carbonate of sodium and the ammonia determined by the Nessler reagent. The results were calculated into percentages of the original leather. Under this treatment samples of new leather of good quality gave the following results:—

	Sulphuric acid (SO_3).	Ammonia (NH_3).
Uncoloured Russia ..	0·25 per cent ..	0·14 per cent
Coloured Russia	0·42 ,, ..	0·21 ,,
Sheep, oak-tanned ..	0·21 ,, ..	0·08 ,,

A sample of *well-worn* but not *decayed* sheep was taken from the side of a family bible, printed in 1814, and presumably in the original binding. The book had never been exposed to gas. The leather was found to contain:—

Total sulphuric acid .. .. 1·42 per cent.

A sample of very rotten Russia, which was very strongly acid to taste and to test-paper, contained:—

Total sulphuric acid .. .. 8·4 per cent.

Another lot, scraped from a number of books, contained:

Total sulphuric acid	10·6 per cent
Ammonia..	3·1 ,,

In this case the "acidity" of the extract was determined. The greater part of the acidity was due to the presence of sulphuric acid, either "free" or as an "acid salt." Reckoned as sulphuric acid it amounted to 4·2 per cent.

Another sample contained:—

Total sulphuric acid ..	6·4 per cent
Free or an "acid salt" ..	2·4 ,,
Ammonia	2·4 ,,
Lime	0·1 ,,
Alumina	No more than a trace.

These determinations indicated to me that the sulphuric acid was in considerable measure present as sulphate or acid sulphate of ammonium. I then performed the following experiment:—

A quantity—about 20 grms.—of the rotten leather was carefully extracted with water, and after dialysing the extract several times and allowing the dialysed liquid to crystallise, I obtained about a grm. of white crystals which were but slightly acid to test-liquids, and were found to contain:—

Sulphuric acid (SO_3)	56·43 per cent
Ammonia	23·20 ,,
Non-volatile matter	10·23 ,,

The non-volatile matter contained something insoluble in chlorhydric acid, also some lime and an amount of sulphuric acid equivalent to 4·01 per cent of the original crystals. Leaving out this sulphuric acid which remained in the "ash," the composition of the portion driven off by heat would be:—

Sulphuric acid (SO_3)	58·39 per cent
Ammonia	25·84 ,,
Water and loss	15·77 ,,
	100·00 ,,

The theory for the normal sulphate of ammonium is:—

Sulphuric acid (SO_3)	60·60 per cent
Ammonia	25·76 ,,
Water	13·64 ,,
	100·00 ,,

It would seem, therefore, that in this case the crystalline salt obtained was mainly the normal sulphate of ammonium. In other cases, however, the impure crystals obtained evidently contained some of the acid salt.

In view of these facts, it would certainly seem that bindings of Russia, calf, or sheep, when exposed to the products of the combustion of illuminating gas, do absorb sulphuric acid. It is difficult, otherwise, to account for the large amount, 8 and 10 per cent, which is found in the rotten leather. A small amount might come from sulphate of lime in the leather, from sulphate of iron used in staining the backs, and from other sources, but the amount in the samples of new leather which I have examined is very small, and the largest amount that I have ever found, except where I knew the leather had been exposed to gas, was in the sides of a dilapidated copy of Athanasius Kircher's Magneticum Naturæ Regnum. The history of the binding was unknown as well as its age; it was very "greasy," and from it water took out 4·9 per cent sulphuric acid. It was somewhat acid to taste, but it is not unlikely that the book had, in the course of its long history, been exposed to sulphurous acid from the combustion of soft coal, or indeed to gas itself. The same leather contained 2·2 per cent of ammonia, but this could easily be accounted for. As in other cases, more or less ammonia may come from the air, from the decay of the paste, from the leather itself, and some, no doubt, from the gas in certain cases.

With reference to the source of the sulphuric acid, it has been objected that the sulphur compounds burn mainly to sulphur*ous* acid and not to sulphur*ic*. I analysed some of the deposit which formed on a galvanised iron plate which received the water condensed on the under surface of a "water-bath" when the gas was first lighted. I found the salt present to be a sulph*ate*, and could obtain no evidence of a sulph*ite*.

As it has been suggested that the alum in the paste might explain the sulphuric acid, I took some of the scraped backs and examined a portion containing the paste and paper of the back as well as some leather. The results were:—

Total sulphuric acid	3·55 per cent
Alumina (with trace of iron) only	0·42 ,,

It has further been suggested that it is the fault of the leather. I cannot prove that this is not so, and as a part of the investigation I desire to examine some decayed backs which have never been exposed to gas. This I have not been able to do. Although I have been promised such backs I have never received them. I may say in this connection that some of the books which I have examined were bound by a man now engaged in the same library, and he claims to know that the leather was good when put on

I think the evidence collected throws such suspicion on the gas burned that one would be justified in insisting upon better ventilation, and in recommending that the burners should be arranged, when practicable, so that the products of combustion should be drawn by a ventilating chimney or pipe away from each burner without mixing with the air of the room. In one of the London libraries, referred to by Dr. Letheby, better ventilation was determined upon, and, as I understand it, with gratifying results.

To settle finally the vexed question, I have laid out the following plan:—I propose to have a set of books bound at the same time by the same person, using the same leather and paste. These books are, some of them, to be put in the most exposed situation, one of them to be carefully examined now, one after a year's interval, another after two years, and so on. Meanwhile two of the same set are to be put where they will not be exposed to gas, but where they will quietly grow old. I believe this, coupled with an examination of the air, which I hope to make, will settle the question.

It should be said that the books which are most decayed have been upon the upper shelves of the library, where

they are subjected to a high temperature, and it is of course *possible* that the disintegration of the leather has given an opportunity for the absorption of the vapour of sulphuric acid and ammonia rather than that the absorption is the cause of the disintegration.

[The writer of the above paper would be pleased to receive for further research any samples of leather binding whose history can be well ascertained.]

ACTION OF BONE-BLACK ON SOLUTIONS OF PURE SUGAR.

By P. CASAMAJOR.

In a paper published in the *American Chemist*, for November, 1871, "On the Purification of Sugar Solutions for the Optical Saccharometer," I gave an account of experiments made with dry bone-black on sugar solutions. These experiments led me to differ from the conclusions to which Dr. Schiebler had arrived, that bone-black absorbs sugar from its solutions, and that, therefore, the use of bone-black, even when thoroughly dried, tends to give results with the saccharometer that are lower than they would be without the use of bone-black.

My attention was called to this subject again during the latter part of 1878 by several communications of our regretted fellow member, Professor J. M. Merrick, of Boston, to the Chemical News. In these communications Professor Merrick cites many authorities who agree in this: that the use of bone-black, in tests by the optical saccharometer, tends to give results that are too low. In addition to citing these authorities, he gave experiments, made by himself, which confirm the opinion of the authorities cited by him. He found in several cases that when using bone-black the results were from 0·5 to 0·8 per cent lower than they were previous to using bone-black. Prof. Merrick wrote to me at the time, calling my attention to these results, and I answered that, being very busy with other things just then, I had not time to go over the subject.

Since that time, during February of this year, I made some experiments to discover whether bone-black really absorbed pure sugar from its solutions. In these experiments I made use in one case of a solution of pure sugar, and in another case of a solution of good loaf-sugar. The pure sugar was obtained by soaking good loaf-sugar in alcohol for over twenty-four hours, washing the crystal with more alcohol, and finally drying the sugar over a water-bath. The object of using pure sugar, or nearly pure, was to eliminate errors which might result from the unequal absorption of bone-black of the impurities that exist in commercial sugars. These impurities are of many kinds, but it generally happens, with sugar of high grade, that the impurities are in such a condition that they exert no action on polarised light, so that, on making the correction after inversion, the corrected result is almost always the same as the direct test, when we operate with sugars of 90 per cent or over.

There being a possibility that the effect of bone-black in lowering the saccharometric degree was due principally to its power of removing dextro-gyrate impurities in greater quantity than the lævo-gyrate, the use of pure sugar would eliminate any error from this cause.

The experiments were conducted in such a way as to leave no doubt on the question whether bone-black took up sugar from its solutions. A weight of bone-black was used which was many times greater than the weight of sugar that filtered over it.

First Experiment.—This was made with 125 c.c. of recently and thoroughly dried new bone-black. These 125 c.c. weighed 79 grms. The bone-black was not washed to remove the salts.

The solution of pure sugar that was filtered over these 79 grms. of bone-black had a sp. gr. of 1·052 = 12·75° Balling. In the optical saccharometer it stood at 51·5 per cent. These numbers give a coefficient of purity = 100. A volume equal to 80 c.c. was allowed to run out, the operation taking one hour. This portion that came through had a specific gravity of 1·057 = 13·05° Balling. In the optical saccharometer it stood at 49 per cent. These numbers give a coefficient of purity equal to 92·8 per cent.

This fall in the coefficient of purity from 100 to 92·8 cannot be due to absorption of sugar, although the fall in the saccharometric indication from 51·5 to 49 per cent shows that sugar has been removed from the solution. The decrease in the coefficient of purity can only come from the impurities present in new bone-black, and points to the necessity of washing new bone-black before passing sugar solutions over it.

As the quantity of bone-black was very large in proportion to the weight of sugar that filtered over it, the quantity of sugar removed from the solution may be taken as being very nearly the quantity which 79 grms. of new bone-black can absorb. To ascertain this quantity of sugar let us take 80 c.c. of the solution, such as it went on the bone-black, its specific gravity being 1·052; the weight of the solution was $80 \times 1{\cdot}052 = 84{\cdot}16$ grms.

The degree Balling being 12·75, and the coefficient of purity being 100, the whole weight of sugar in the 84 16 grms. of solution was $0{\cdot}8416 \times 12{\cdot}75 = 10{\cdot}73$ grms. of pure sugar.

The 80 c.c. of solution which filtered through the 79 grms. of bone-black in the space of an hour had a specific gravity of 1·057, which gives for the 80 c.c. of solution a weight of $80 \times 1{\cdot}057 = 84{\cdot}56$ grms. The degree Balling of these 84·56 grms. being 13·05, and the coefficient of purity 92·8, the quantity of pure sugar in the filtered 80 c.c is $= 0{\cdot}8456 \times 13{\cdot}05 \times 0\ 925 = 10{\cdot}25$ grms.

Subtracting this from the quantity of sugar previously obtained, we have $10{\cdot}73 - 10{\cdot}25 = 0{\cdot}48$ grm. as the weight of sugar absorbed by 79 grms. of new bone-black, which is equivalent to 0·606 grm. as the quantity of sugar absorbed by 100 grms. of new bone-black.

Second Experiment.—This experiment closely resembles the first. The bone-black used was the ordinary bone-black of the refinery. The quantity taken was 125 c.c., weighing 100 grms. The bone-black was thoroughly dried, as in the first instance.

The solution of loaf-sugar filtered over these 100 grms. of old bone-black had a specific gravity of 1·051 = 11·5° Balling. In the optical saccharometer it stood at 46 per cent. These numbers give a coefficient of purity equal to 99·5.

As in the previous case, a volume equal to 80 c.c. was allowed to run through the filter in the course of one hour.

The portion that came through had a specific gravity of 1·044 = 10·95° Balling. In the optical saccharometer it stood at 43·3 per cent, which gives a coefficient of purity equal to 98·6.

We may notice here at once that the fall in the coefficient of purity is insignificant when compared to what happened with new bone-black: still it points to impurities absorbed by the old bone-black.

If we go over the same calculations as in the first expement we find that the weight of the 80 c.c. of solution was $80 \times 1{\cdot}051 = 84{\cdot}08$ grms. The total number of grms. of sugar in 80 c.c. $= 11{\cdot}5 \times 0{\cdot}8408 \times 0{\cdot}996 = 9{\cdot}63$ grms.

The 80 c.c., after filtering over 100 grms. of old bone-black, weighed $80 \times 1{\cdot}044 = 83{\cdot}52$ grms., and the total weight of pure sugar in the filtered portion was $10{\cdot}95 \times 0{\cdot}8352 \times 0{\cdot}986 = 9{\cdot}01$ grms.

If we subtract this quantity from 9·63, belonging to the 80 c.c., before going on the bone-black, we have $9{\cdot}63 - 9{\cdot}01 = 0{\cdot}62$ grm. as the weight of sugar absorbed by 100 grms. of old refinery black.

Conclusions.

These numbers, 0·606 grm. for the quantity of pure sugar absorbed by 100 grms. of new black and 0·63 grm. for the

quantity of pure sugar absorbed by 100 grms. of old black, are remarkably close, particularly if we consider the degree of approximation compatible with sugar analysis.

The quantity of sugar absorbed by 100 grms. of bone-black may be put down as 0·6 grm. It is possible that new bone-black may generally absorb slightly more or less sugar than the old, but this point can only be settled by a great number of tests.

To return to the action of bone-black in sugar tests, there seems little doubt that in many cases the addition of bone-black seems to lower the saccharometric test. This action must in part be due to the comparatively greater absorption of the dextro-gyrate impurities that are found in commercial sugar.

As to the absorbing action of bone-black on sugar, if, as the above experiments show, this absorption is about 0·006 of the weight of the black employed, there must be no perceptible error in shaking a small quantity of fine bone-black with the solution previous to filtration. A quantity of black equal to 4·5 grms., shaken with 100 c.c. of sugar solution, will almost always produce a marked improvement in the colour of the solution. If this quantity of bone-black absorbs 0·006 of its weight of sugar, this absorption will be equal to $0{\cdot}006 \times 4{\cdot}5 = 0{\cdot}027$ grm. Now this quantity divided by 26·048 grms. (the quantity dissolved in 100 c.c. of solution) will give $\frac{27}{26048}$, which is very approximately = 0·001, or one-tenth of 1 per cent, and this is the error which $4\frac{1}{2}$ grms. of bone-black may produce from its property of absorbing pure sugar. By absorbing dextro-gyrate impurities a greater error may arise, but I regret to say that I have not tried to solve this problem, which is well worthy the attention of chemists.* —*Journal of the American Chemical Society*, vol. i.

ON THE

ESTIMATION OF THE NITROUS COMPOUNDS

IN THE VARIOUS STAGES OF THE

MANUFACTURE OF SULPHURIC ACID.†

By JAMES MACTEAR, F.C.S., F.I.C.

(Concluded from p. 54.)

SUMMARY.‡

Found in 100 c.c.	*a* 0·00209	N_2O_3	and = 1·6278	N_2O_5
,, ,,	*b* 0·03664	,,	= 4·71067	,,
,, ,,	*c* 0·01957	,,	= 0·47457	,,
,, ,,	*d* 0·8859	,,	= 0·0797	,,

The amount of N_2O_5, formed in the above experiment, will show how it is that a single day's carelessness may utterly ruin a vitriol chamber by the destruction of the lead from the action of the nitric acid. The amount of acid run down the Gay-Lussac was not altered during the experiment, which accounts for the low percentage of nitrous compounds, 0·9416 N_2O_3, by ammonia process.

If we calculate this nitrous vitriol to the strength of Dr. Lunge's specimen, viz., 0·413 grm. N_2O_3 per 100 c.c., the N_2O_5 would amount to 0·37 grm. per 100 c.c.; or if the N_2O_3 be called 100, the N_2O_5 is as near as may be 9 per cent.

The method of working chambers has a great deal to do, no doubt, with the character of the last gases passing into the Gay-Lussac, and it is evident that where there is only a short distance between the chambers and Gay-Lussac column, the condensation of the N_2O_5 formed will be imperfect, and it will be found in the nitrous vitriol. On the other hand, if the distance is considerable (in the above experiments it was about 200 feet), and the drainage to the chambers, the amount found in the nitrous vitriol will be the less, and in any case the amount will be irregular.

It appears to me that while we may say that in any special case we have found such-and-such results as to composition of the gases or of the acid, we can not apply such results as a general principle applicable to all cases; the variations are very great, and require to be studied almost for each short period of time, as well as for each set of plant, and it may well be asked what is the use of our generalising as we are too prone to do on such a subject.

12. The subjoined tests from plant working under normal conditions and giving good results, will be interesting:—

(*a.*) Glover tower acid, 149° T. = sp. gr. 1·745, having a reddish colour; this disappeared on heating, but returned on cooling again. It disappeared altogether on the addition of a piece of zinc.

It gave in 100 c.c.:

	Grm.	
1. By permanganate process	0·04235	N
2. ,, ammonia ,,	0·02940	N = as N_2O_3 0·0798
Excess from 1	0·01295	N = SO_2 0·059*

(*b.*) Glover tower acid, smelling *strongly* of nitrous compounds; strength of acid, 149° T. = 1·745 sp. gr.

It gave in 100 c c.:—

1. By permanganate process	0·2018 grm.	N
2. ,, ammonia ,,	0·1969 ,,	N
Excess N from 1	0·0049 ,,	N = SO_2 0·0224*

(*c*) Glover tower acid, smelling *strongly* of sulphurous acid; strength of acid 149° = 1·745 sp. gr.

It gave in 100 c.c.:—

1. By permanganate process	= 0·05712 grm. N
2. ,, ammonia ,,	= 0·04872 ,, N
Excess N from 1	= 0·00840 ,, N SO_2 = 0·0384*

(*d.*) Gay-Lussac acid, dirty-looking in appearance; strength, 148° T. = 1·740 sp. gr.

It gave in 100 c.c.:—

	Grm.	
1. By ammonia process	= 0·34160	N
2. ,, permanganate ,,	= 0·33425	N
Excess N from 1	= 0·00735	N as N_2O_5 = 0·02835

2·15 per cent of the N being in the state of N_2O_5.

(*e.*) Last drip of last chamber in No. 8 series, under ordinary conditions of working. The acid very clear; gas given off on standing, whice turns red in air.

The chamber was very high in colour at time of sampling; strength of acid, 80° T. = 1·400 sp. gr.

100 c.c. gave:—

	Grm.	
1. By ammonia process	= 1·463000	N
2. ,, permanganate ,,	= 0·004375	N
Excess N from 1	= 1·458625	N = as N_2O_5 0·56261

99·7 per cent of the N present being in the state of N_2O_5.

(*f.*) The last drip from the fifth set of chambers, under ordinary conditions of working; strength, 81° T. = 1·405 sp. gr.

---

* Dr. Scheibler has called attention to the error committed in saccharometric tests by using basic acetate of lead. As the precipitate obtained occupies a certain volume, this volume must be deducted from the 100 c.c. measured by the graduated flask. By using a volume of liquid smaller than 100 c.c. the result obtained is necessarily too high. This being the case, a sufficient quantity of bone-black, shaken up with the solution, may act as a corrective by lowering the saccharometric degree. If there was any constancy in the effect of acetate of lead in raising the saccharometric degree, and of bone-black in lowering the test, it would be possible to neutralise a certain volume of basic acetate by a corresponding weight of bone-black. Unfortunately, if I am not mistaken, experiments are wanting to elucidate this subject.

† A Paper read before the Newcastle-upon-Tyne Chemical Society.

‡ See also table at end of the paper.

* Stated as SO_2 for simplicity; actually it is oxidisable matter present, As_2O_3, in considerable quantity

It gave in 100 c.c. :—

1. By ammonia process 0·3332 grm. N
2. „ permanganate „ 0·00525 „ N

Excess N from 1 0·32795 „ N = as N_2O_5 1·265

98·4 per cent of the N present being in the state of N_2O_5.

(*g.*) Acid from a Glover tower became reddish on cooling; strength of acid, 150° T. = 1·750 sp. gr.

It gave in 100 c.c. :—

	Grm.	
1. By permanganate process	0·06111	N
2. „ ammonia „	0·05152	N

Excess N from 1 0·00959 N = SO_2 0·0438*

(*h.*) Average of last drips of *six* series of chambers, working under ordinary condititions; strength of acid, 73·5° T. = 1·3675 sp. gr.

It gave in 100 c.c. :—

1. By ammonia process 1·2838 grm. N
2. „ permanganate „ 0·0063 „ N

Excess N from 1 1·2775 „ N = as N_2O_5 4·9275

99·5 per cent of the N present exists as N_2O_5.

It would, I think, be clearly absurd to assume from such results that a sample of Glover tower acid which *smells very strongly* of sulphurous acid should not contain a greater proportion than one which smells as strongly of nitrous compounds.

And from results such as that of sample A, as well as its rather stable characteristics and its absorption by ferrous sulphate, I am inclined to believe that there is present in Glover tower acid, under certain conditions as yet undetermined, appreciable quantities of N_2O_2, and that there is reason to believe that this holds good also with the Gay-Lussac acid or nitrous vitriol.

In fact, if we calculate the effect of the arsenic, under the assumption that in the Glover tower acid, containing sulphurous acid, at least that it exists as As_2O_3, we will see that, on the test by permanganate, there will not be oxygen enough to oxidise the N compounds fully to even N_2O_3.

The sulphate of nitrosyl is a well enough known body, and has been examined by many eminent workers, and it would require more proof than mere assertion on the part of modern investigators to convince us that the work of the older and oft-times more patient worker was untrustworthy and incorrect.

[We have had only recently a grand corroboration of the views of one of these older men, in the victory over the gases, of MM. Cailletet and Pictet, whose patient labour and sound scientific reasoning has been crowned with the success it merits. I think, Sir, with all deference, that this is just one of these occassions on which we as a Society ought to express our congratulations to both these gentlemen, on their having (quite independently of each other) so successfully reached their goal.]

The complete investigation of this subject for *any* given set of conditions alone is one which would prove of the most laborious and complicated description, and is quite beyond the province of one to make whose time, like my own, is fully occupied with the multifarious details of technical work. I trust, however, that the results of the investigation which I have to-night submitted to you will be of use in two directions:—

1st. In giving some indication of the methods of testing the loss of nitrous compounds.

2nd. In opening up a discussion on the subject generally, which may—nay, must—add to our knowledge of the subject, and enable us to obtain more clearly an insight into the reactions and conditions under which we direct our labour in the manufacture of sulphuric acid.

I have to apologise for the great length to which this paper has extended, but I trust you will excuse this in consideration of the great interest the subject possesses.

I am sorry also to have to differ so completely from Dr. Lunge, and to have to criticise so adversely his recent paper in the way I have done: but as his object, like mine, is to get at the truth, I am certain he will take all I have said in good part.

ON THE ARTIFICIAL PRODUCTION OF PRECIOUS STONES.

By ALFRED H. ALLEN, F.C.S.

On Wednesday evening Mr. Alfred H. Allen, the borough analyst for Sheffield, read a paper at the School of Art, before the members of the Literary and Philosophical Society, upon "Artificial Precious Stones." Dr. Hime presided.

Mr. Allen said that synthetical mineralogy, or the artificial production of natural minerals, was a subject which had always caused great interest, and was likely to be of very considerable commercial importance in the future. A study of the chemistry and mode of occurrence of minerals had resulted in attempts, many of which had been successful, to obtain those minerals by artificial means. Of the substances used for ornamental purposes and usually classed as precious stones, a very large number consisted of silica in a state of greater or less purity. As instances of these he mentioned rock-crystal, amethyst, cairngorm, aventurine, agate, cornelian, onyx, jaspar, calcedony, chrysoprase, and opal. With the exception of the last of these, the varieties of silica were not of very great value for ornamental purposes, and many of them were capable of close imitation by glass. Microscopic crystals of quartz or silica were obtainable by various methods, and very fair imitations of artificial opal had also been prepared, though such products never rivalled the natural opal in their play of colours. Several silicates used as precious stones had been intentionally prepared or had been noticed among mineralogical products. Garnet, zircon, hyacinth, and topaz were instances of these. The beryl or emerald had also been obtained by synthetical means. The stone known to mineralogists as corundum, and to jewellers as sapphire, oriental ruby, or oriental emerald, according to its colour, consisted chemically of pure crystallised alumina, and had been obtained by various artificial means. Most of the processes, however, were only capable of giving it in very small quantity or very minute crystals, but Messrs. Fremy and Feil had recently conducted operations on a very large scale, and their success had completely eclipsed that of all previous

SUMMARY OF TESTINGS.

	Degrees Tw.	Grammes. In 100 c.c.		Weight in Grms. of 100 c.c.	On Total Weight. Per cent.		Per cent of SO_3 in Acid.	SO_3 in 100 c.c. of Acid.	Per 100 of SO_3.		Per 100 of N. N existing as	
		N_2O_3.	N_2O_5.		N_2O_3.	N_2O_5.			N_2O_3.	N_2O_5.	N_2O_3.	N_2O_5.
A.	38	0·0022	1·628	119	0·0018	1·3681	21·22	25·2518	0·0087	6·4471	0·18	99·82
B.	73	0·0366	4·7107	136·5	0·0268	3·4511	37·91	51·7471	0·0707	9·1033	1·09	98·91
C.	57	0·0195	4·7458	128·5	0·0152	3·6932	30·61	39·33385	0·0496	12·0654	0·58	99·42
D.	149	0·8860	0·0770	174·5	0·5077	0·0441	66·12	115·3794	0·7679	0·0667	94·08	5·92
E.	60	0·01188	5·6261	140	0·0085	4·0186	40·81	57·1340	0·0208	9·8472	0·30	99·70
F.	81	0·01425	1·2650	140·5	0·0101	0·9003	41	57·6050	0·0247	2·1960	1·60	98·40
H.	73·5	0·0171	4·9275	137	0·0125	3·5967	38·36	52·5532	0·0325	9·3762	0·50	99·50

investigators. They had very recently operated on 50 or 60 lbs. of material which they kept heated uninterruptedly for 20 days. In this manner they obtained crystals of artificial corundum, either blue, red, or green, as desired, capable of scratching quartz and topaz, and indistinguishable from the natural precious stone. Messrs. Fremy and Feil had not patented their processes, and there was every reason to believe that these would be shortly extensively applied. Another natural product often used for ornamental purposes, and now manufactured artificially on an enormous scale, was the *lapis lazuli*, better known in its artificial state as ultramarine. The natural substance was extremely costly. In 1829 the artificial product, equal in every respect to the natural, was worth £12 a lb., but it was now less than 6d. a lb. The total production in 1872 was over eight million kilogrms. The most valuable of all precious stones, valued on account of its lustre, rarity, and extreme hardness, was the diamond. The diamond was well known to chemists to consist of pure carbon in a crystallised state, and very many attempts had been made to prepare it artificially. Great obstacles stood in the way of success, the chief being the complete insolubility of carbon in all known liquids, its non-volatility, ignorance of the conditions under which the diamond was produced in nature, its great rarity, and hence the presumed rare natural existence of the conditions for its formation, its crystalline form, and hence the probable very slow formation. The artificial production of the diamond, although presenting inherent difficulties of the highest order, was not a mere philosopher's day-dream, like the discovery of perpetual motion, transmutation of metals, or the squaring of the circle. The production of adamantine carbon—the same thing as diamond—was so far within the reasonable bounds of possibility that the wonder was that it had not already been definitely effected, and no chemist would be greatly surprised to hear that the problem had been fully solved. Quite recently several new claimants had arisen for the honour of having solved the problem of obtaining artificial diamond. The most notable of these was Mr. James Mactear, managing partner or director of Messrs. Tennant's celebrated chemical works at Glasgow. Mr. Mactear was well known as an ingenious and able practical chemist, and when he announced that he had solved the problem chemists were quite prepared to congratulate him on his success. Mr. Mactear recently went so far as to submit some specimens of what he believed to be diamond to the experts of the British Museum, and much to the surprise of the scientific world it was now definitely admitted, even by Mr. Mactear himself, that these specimens were not real diamonds. How Mr. Mactear could have been deceived originally as to their real nature was a matter of mystery. In the opinion of Mr. Allen, by far the most hopeful direction in which we had to look for the artificial production of diamond was based on the curious fact very recently discovered that gases under high pressure had a very marked power of dissolving solids. This extraordinary discovery had a bearing on the recently reported spontaneous rupture of a diamond. It was assumed, with great probability, that the explosion was due to the pressure of a cavity containing highly compressed gas, which was supposed to have been carbonic acid. If this supposition were proved to be true it would throw enormous light on the natural mode of forming diamond, and might prove the key to its artificial production. It was impossible to omit mention of the investigations of a native of Sheffield, Dr. R. S. Marsden, an old pupil of his, who had recently been experimenting on the production of crystallised elements. He had got a crystalline form of something, which he (Mr. Allen) thought might possibly be diamond. By an entirely different process from anything issued before he had obtained a crystalline body, which was very probable to be crystallised carbon,—in other words, diamond. The economical production of artificial diamond, even of minute size, would be of immense importance in the arts, and diamond wheels would soon replace emery wheels. The production of diamonds of sufficient size for ornamental use would probably soon follow the other discovery, and for a time at least such stones would command a very high price. The economical production of diamonds of fair size would lead to their extensive and habitual employment for rock-boring, stone-cutting, and all similar purposes. He was so sanguine that the artificial formation of diamond was practicable that he should regard with the greatest interest the formation of any company or similar association which might be established to ascertain the possibility of making such a production.

A cordial vote of thanks was given to Mr. Allen for his able lecture.

CORRESPONDENCE.

TESTING OF VITRIOL CHAMBER EXITS, &c.

To the Editor of the Chemical News.

Sir,—Allow me to state that the method for the examination of chamber exits given by Mr. Vasey in the Chemical News (vol. xli., p. 47) was fully described by me in a paper read before the members of the Faraday Club, on February 19th, 1879, having been in use in my laboratory for nearly twelve months previously. It is strange Mr. Vasey has forgotten this, for on September 20th, 1878, he collected for me the gases passing an exit which I examined by this very method, being the results of a 22½ hours' aspiration. These results were given in the paper alluded to, and I am glad to have the pleasure of thanking him for stating the convenience and accuracy of the process. I pointed out, however, to the members present that peroxide of hydrogen was more easily deprived of its oxygen when alkalies were present, and that is why I advised the exit gases to be drawn through diluted peroxide, and the acid solution titrated with normal soda, which, after acidifying and evaporating, was to be transferred to the nitrometer. By this means a minimum of sulphate of soda is introduced into the tube.

Mr. Whewell seems rather in a fog as to the action of chloride of magnesium in causing mildew on cotton goods. Your reviewer was quite correct in stating that it acts by virtue of its property of absorbing moisture, and I fail to see that your correspondent has established any other proposition.

Mr. Menzies's letter (Chemical News, vol. xli., p. 22), extolling the virtues of chlorate of potash as against those of bichromate, calls for a few remarks as a guide to your practical readers. Bichromate of potash is a splendid oxidiser, and quite safe even when mixed with strong sulphuric acid; chlorate of potash, on the contrary, explodes violently when heated with strong sulphuric acid—in fact accidents have happened by mixing these substances in large quantities *in the cold*. Again, when oxidising organic compounds with chlorate of potash, chloro-compounds of quite a different nature to those compounds obtained by the use of bichrome and sulphuric acid are often formed, and, last and not least, there is danger in storing and using chlorate, which there is not with bichromate of potash. Commercial chlorate and commercial bichrome are sold in a state of great purity. When chemist to the firm of J. C. Gamble and Sons, of St. Helens, one of the largest producers of chlorate in this country, I usually examined the chlorate once a week for impurity: there is a most minute quantity of $CaCl_2$ in all, but I could only estimate the amount of impurity by taking such large quantites as 100 grms. The chloride has often been *below* 0·001 per cent, or 1 part in 150,000 actual chlorate.

In the Chemical News (vol. xli., p. 11), under the head of "Notes from Foreign Sources," it appears that the *Transactions of the Society for the Promotion of Industry* contains a paper by Jul. Post on the Composition of Wel-

don Mud, the reproduction of which is strictly prohibited. Can any of your German correspondents give a reason for this, and state how Industry is to be *promoted* by such measures?—I am, &c.,

GEORGE E. DAVIS.

Heaton Chapel, January 27, 1880.

TESTING OF VITRIOL CHAMBER EXITS.

To the Editor of the Chemical News.

SIR,—I notice that Mr. T. E. Vasey (CHEMICAL NEWS, vol. xli., p. 47) lays claim to the application of the mercury nitrometer to the testing of vitriol exits so long ago as "the beginning of May last year." He should be aware that this test was in use long before this in Mr. Davis's laboratory, and he (Mr. Davis) described it in a communication to the Faraday Club read on January 22nd, 1879. I know that in the fall of 1878 Mr. Davis persuaded several chemists to use it, myself amongst the number, but several of them saw difficulties in the transference of the residue of evaporation to the nitrometer, and preferred their own processes. When I succeeded Mr. Vasey as Manager of these Works I found that the old process of estimating the nitre *by difference* was in use: this is, as a scientific method, so exceedingly unsatisfactory—as *all* errors are put on to the nitre—that I caused Mr. Davis's process to be used instead. It has been used ever since, and I find it both quick and accurate.—I am, &c.,

W. JESSE LOVETT.

Victoria Chemical Works, Bradford, Manchester.

ALCOHOL TABLES.

To the Editor of the Chemical News.

SIR,—Your correspondent Mr. S. Cohné (CHEMICAL NEWS, vol. xli., p. 57) mentions the fact that several of our standard works contain no tables for the calculation of proof-spirit to the percentage of alcohol by volume, as used on the Continent. Mr. Cohné gives several formulæ for effecting such calculations, but as they are somewhat clumsy I hope to be excused for giving the following methods, which I quote from a recently-published work* in which I take a special interest:—

1. The percentage by volume of absolute alcohol is obtained by multiplying the percentage of proof-spirit by the factor 0·5706.
2. By multiplying the percentage of alcohol by weight by the observed specific gravity, and dividing the product by 0·7938, the percentage of alcohol by volume is obtained.
3. By dividing the percentage of alcohol by volume by 0·0706, the percentage volume of proof-spirit is obtained.
4. The percentage of alcohol by weight, multiplied by the specific gravity, and the product by 2·208, gives the percentage by volume of proof-spirit.

If we express the percentage of alcohol by weight as W, the density by D, the percentage of alcohol by volume as V, and the percentage of proof-spirit by P, the above instructions can be expressed by the following formulæ:—

1. $V = P \times 0{\cdot}5706$.
2. $V = \frac{WD}{0{\cdot}7938}$.
3. $P = \frac{V}{0{\cdot}5706} = V \times 1{\cdot}7525$.
4. $P = WD \times 2{\cdot}208$.

I note that Mr. Cohné takes the specific gravity of proof-spirit at 0·9186 instead of 0·9198, and this makes his contained percentage of alcohol by volume 57·27 instead of 57·06; but it is not necessary to enter into the cause of these differences.—I am, &c.,

ALFRED H. ALLEN.

Sheffield, January 31, 1880.

* "Commercial Organic Analysis," vol. i., p. 90. J. and A. Churchill.

THE UNFERMENTED WINE CASE.

To the Editor of the Chemical News.

SIR,—In your report of the unfermented wine case (CHEMICAL NEWS, vol. xli., p. 56) there is a slight error in regard to the amount of ash: it should be 0·019 (not 0·91) in 100 c.c. This will equal 13·3 grains grains to the gallon; the chemist for the defence made it 0·020 per cent, or 14 grains to the gallon. If there had been even one-sixth part of grape-juice in the so-called wine, the ash would have amounted to nearly 50 grains in the gallon.—I am, &c.,

J. CARTER BELL.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 2, January 12, 1880.

Observations on a Note by M. Wurtz (*Comptes Rendus*, Session of December 22, 1879, lxxxix., p. 1062).—The discussion on the question of chloral hydrate appears in danger of degenerating into an exchange of personalities.

Influence of the Nature of the Charcoal upon the Electric Light.—Th. du Moncel.—The author calls attention to the experiments which he made as far back as 1855, in order to show the advantages resulting from the use of charcoal of vegetable for increasing the lustre of the electric light.

The Photographic Spectra of the Stars.—W. Huggins.

Glycogenesis in Infusoria.—A. Certes.—As far as the researches of the author have extended they seem to support the law of Claude Bernard.

Thermic Laws of Electric Sparks, produced by the Ordinary Incompletes and Partial Discharges of Condensers.—E. Villari.—*First Law*:—The galvanometric deviations produced by incomplete discharges are proportional to the quantities of electricity constituting the discharges themselves. *Second Law*:—The heat occasioned by the spark produced by the incomplete discharge is directly proportional to the quantity of electricity forming the spark.

Variations of Magnetic Declination Deduced from the Regular Observations made at Moncalieri, 1871 to 1878.—F. Denza.—Not susceptible of abstraction.

Potash contained in the Clay of Arable Soils.—A. Perrey.—Clays constantly contain potassa in quantities ranging from 1·8 to 7·3 (?) per cent.

Dissociation-Tension of Chloral Hydrate, and the Tension of the Vapour of Anhydrous Chloral.—MM. Moitessier and R. Engel.—The authors conclude that unless their experiments are inaccurate the vapour of chloral hydrate is merely a mixture of the vapour of water and of anhydrous chloral, and the hydrate is not decomposed and volatilised in the vapour of anhydrous chloral at a sufficient tension.

Les Mondes, Revue Hebdomadaire des Sciences. No. 2, January 8, 1880.

Changes in the Specific Gravity of Steel in Consequence of Tempering and Annealing.—C. Fromme.—The conclusions are drawn that hardening decreases the specific gravity of the steel, the increase of volume being slighter as the ingot is thicker. (This phenomenon has long been noticed; see "Useful Metals and their Alloys," published in 1857.) Tempering has the opposite effect.

THE CHEMICAL NEWS.

VOL. XLI. No. 1055.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 62.)

IT still remains for me to mention a possible modification in the atomic weights of *yttrium* and of *erbium* (perhaps also of *terbium*, if terbium is really an element existing in nature). However, the history of these interesting elements is still enveloped in darkness, according to the contradictory debates between Mosander and Delafontaine on the one hand, and Bunsen and Bahr on the other hand; they therefore require fresh researches. If we keep to the results obtained by these two last investigators, and if we admit with them that the equivalent of Yt = 30·85 (Berzelius found 32·1 and 35·0, Bopp found 34, and Delafontaine found 32), and that the equivalent of Er = 56·3,* except from any error resulting from them having been insufficiently studied, these elements can be placed in Group III., which receives the highest forms of oxides, such as R_2O_3. Yttrium, with the atomic weight 88, would come in the sixth series, immediately after Rb = 85 and Sr = 87, and consequently before Zr = 90 and Nb = 94; therefore the equivalent of Yt would be = 29·3 = $\frac{88}{3}$. As it is very doubtful whether anyone has yet succeeded in separating Yt from Ce, La, Di, Er (perhaps also from Tb and Th), we can admit that the determinations of Bunsen and Bahr coincide sufficiently with the theoretical number.

This place for yttrium is justified, as the results of applying the periodic law to the preceding elements show, viz., by the strongly basic properties of the oxide, by the non-volatility of $YtCl_3$, by the composition of the sulphate, $(Yt_2SO_4)_3,8H_2O$, similar to the composition of the salt which didymium forms analogous to Yt, by the insolubility of the fluoride, &c. The erbium of Bunsen and Bahr, if we take their results as bordering on the truth, apparently belongs to Group III., Series 10, before La = 180, Ta = 182, and W = 184, and it should possess the atomic weight 178; the form of the oxide is therefore R_2O_3, and its equivalent = 59·3. We can explain the low number (56·3) found by Bunsen by supposing that his erbium was not free from yttrium.

To convince us of the exactness of these modifications of the atomic weights of Yt and of Er, we do not know any fact, as we do in the case of the metals of cerite; nobody has determined either the density of their oxides,† their behaviour in the presence of oxidising and reducing agents, or the composition and the form of their double salts. Here, then, more than in any other part of the system, are researches, guided by the periodic law, necessary.

To give another example of the direction in which researches on elements (based on the periodic law) should be made, I propose to pass now to the determination of the properties of elements which are still undiscovered. Without the periodic law, it would be absolutely impossible to foresee any of the properties of unknown elements; and, further, we could not form any idea of what gaps were existing in the series of elements. The discovery of new elements was uniquely the results of observations, and was made either by chance or by the extra powers of thought and perception of the investigator. These discoveries did not offer any special philosophical interest; this is the reason we have seen such a small number of investigators venture on the study of the elements, like an exploring party in a new and unknown land, not knowing which way to turn; but now they will find that this vast and important domain of chemistry is not entirely devoid of landmarks, but that the periodic law will serve as a guide, and will facilitate future discoveries.

IV. THE USE OF THE PERIODIC LAW FOR DETERMINING THE PROPERTIES OF AS YET UNDISCOVERED ELEMENTS.

The preceding developments show us that the periodic law renders it possible for us to bring to light the unknown properties of elements whose atomanalogues are known to us. Further, we can see, by referring to Tables I. and II., in which the periodic relations are shown, that many elements are missing, and we can confidently predict their discovery. I am therefore going to describe the properties of several as yet undiscovered elements: by this means I hope to show, in a new and perfectly clear manner, the exactitude of the law, although the confirmation of these proofs is reserved for the future. Let us add that the previous determination of the properties of unknown elements will facilitate the discovery of these elements, because knowing them we can foretell the reactions of their compounds.

So as to avoid introducing new denominations for the unknown elements into science I shall designate them by the name of the nearest lower analogue of the odd or even elements in the same group, and placing in front of this word one of the Sanscrit numbers (eka, dui, tri, tschatour, &c.). The unknown elements of the first group will be called ekacæsium (Ec = 175), duicæsium (Dc = 220), &c. If niobium, for example, were not known we could call it ekavanadium. The denominations will show the analogies very clearly; the names, however, of the fourth series have not this advantage, because they ought to be derived from those of the elements of the second series, and we know from Chapter I. that this typical series is not in complete atomic analogy with the fourth.

Besides, in this series there is only one missing element; it is in the third group, and is called ekaboron, Eb. As it follows K = 39, and Ca = 40, whilst it precedes Ti = 48, and V = 51, its atomic weight should be about Eb = 44; its oxide should be Eb_2O_3, but it should not have very characteristic properties; it will form in all respects the transition from CaO to TiO_2. In its maximum salts, EbX_3, the equivalent of the metal will be about $15 = \frac{44}{3}$; it will not, therefore, be lower than the equivalents of bases which are already known; it will be intermediate between the equivalent of Mg = 12, and that of Ca = 20.

We have seen in the foregoing chapter that Yt = 88 (?), Di = 138 (?), and Er = 178 (?) belong to this same group. However, the position of this latter is still very uncertain, and the elements have not been sufficiently studied; therefore the properties of Eb can only be determined by means of its atomanalogy with the elements Ca and Ti of the fourth series. The case of this element is therefore more complicated than those of other unknown elements. In consideration of Ca and Ti only giving one stable oxide in the air, we may admit that Eb will only give one stable basic oxide, Eb_2O_3. The oxide in its properties ought to be to Al_2O_3 what CaO is to MgO, or what TiO_2 is to SiO_2; consequently it should be a more energetic base than aluminium, and at the same time it ought to agree with Al not only in its forms of corresponding compounds, but also, in many cases, in its properties. Thus, the sulphate $Eb_2(SO_4)_3$ will not be such an easily soluble body as $Al_2(SO_4)_3$, because sulphate of calcium is more difficultly soluble than sulphate of magnesium. The base

* Erbium, according to Delafontaine, has an equivalent lower than 39·68. Bunsen thinks that Delafontaine was working with an impure sample.

† The number 48·4 given by Eckeberg for the oxide of yttrium might be thought to relate to an impure substance. However, it corresponds to the periodic law, for the volume of $2SrO = Sr_2O_2 = 49$, the volume of $Yt_2O_3 = 47$, the volume of $Zr_2O_4 = 45$.

formed by Ca being more feeble than that formed by Na, and, at the same time, TiO_2 being a less energetic base than Al_2O_3, Eb_2O_3 will be weaker than MgO. Eb_2O_3 will therefore occupy, in many respects, the place between Al_2O_3 and MgO: numbers of its reactions will be explained by this circumstance.

Duiboron, or yttrium, gives an oxide, in every respect more energetic, as Sr gives a more marked base than Ca; however, even as there exists a great concordance between Ca and Sr, Ti and Zr, so shall we find many analogies between ekaboron and duiboron (yttrium?). If, then, yttrium is veritably duiboron, and ought to be accompanied by ekaboron, the separation of ekaboron from yttrium will be very difficult; in fact, it will only be possible by means of excessively delicate differences; for example, in the solubility of the salts, or in the energy of the basic oxides, &c.

Oxide of ekaboron will naturally be insoluble in alkalies, but we are uncertain as to whether it will drive off the ammonia from chlorhydrate of ammonia. The carbonate of ekaboron will be insoluble in water, and it will be precipitated as a basic salt, if we can judge from what we know of the salts of MgO and Al_2O_3. Its salts will be colourless, and will give gelatinous precipitates with KHO, K_2CO_3, HNa_2PO_4, &c. Sulphate of potassium will give a double salt with $Eb_2(SO_4)_3$, a sort of alum, which will probably not be isomorphous with alum proper. A few salts only of ekaboron will crystallise well, and they will belong to the double salts. The degree of volatility of $EbCl_3$ will depend on the molecular formula of this compound; $EbCl_3$ will be volatile, but Eb_2Cl_6 and the higher molecules will not volatilise. Chloride of ekaboron will, in all probability, be more difficultly volatilised than chloride of aluminium, because $TiCl_4$ boils at a higher temperature than $SiCl_4$; because also $CaCl_2$ is more difficultly volatilised than $MgCl_2$. But we may be permitted to presume that the salts of ekaboron will not be sufficiently volatile to be discovered by means of spectrum analysis. The chloride of ekaboron will naturally be a solid body: its anhydride will be decomposed by water more easily than $MgCl_2$ with the evolution of HCl.

As the volume of $CaCl_2=49$, and the volume of $TiCl_4=109$, the volume of $EbCl_3$ will be about 78, and its density will be 2.

Oxide of ekaboron will be an infusible powder, which will, after calcination, dissolve in acids, although with difficulty; it will easily give to water its alkaline reactions, but it will not completely saturate acid solutions of litmus so as to make the colour disappear. The density of the oxide will be about 3·5; the volume about 30, because the volume of $K_2O=35$, of $Cu_2O_2=36$, of $Ti_2O_3=40$, of $Cr_2O_6=72$.*

Ekaboron, the simple body, will be a light, non-volatile, difficultly fusible metal. It will only decompose water under the influence of heat, and even then incompletely; it will dissolve in acids, with the evolution of hydrogen. Its density will be about 3·0 (apparently higher), because its volume is about 15; for the volumes of metals in the even series diminish constantly from the first group. Thus the volume of K=50, of Ca=25, of Ti and V= about 9, and of Cr, Mn, and Fe = about 7.

(To be continued.)

Variations of the Electromotive Force of the Batteries of Grove, Bunsen, and Daniell, with the Concentration of the Liquids.—C. Fromme.—Grove's battery is most efficacious when the nitric acid contains 40 per cent of water. In the Bunsen battery the strength of the current diminishes with the concentration of the acid. In Daniell's battery the electromotive force increases with the concentration of the solution of sulphate of copper, but with a less rapidity.—*Les Mondes.*

* Oxide of duiboron (yttria?) should, from an analogical point of view, have for its density the number 4·8 (see above.)

REMARKS ON THE NEW METALS FROM GADOLINITE AND SAMARSKITE.

By M. M. DELAFONTAINE.

Since M. Marignac and I published our memoirs on Terbia, in March, 1878, the real or supposed discovery of ten other rare earths has been announced by different chemists,—namely, mosandria, philippia, ytterbia, decipia, scandia, holmia, thulia, samaria, and two others not yet named. As may be imagined, such a multiplication of bodies difficult to isolate and characterise has provoked scepticism, and it has been suggested that some of them may be duplicates. If the Academy will permit me I will communicate my views on this subject as the result of my own researches.*

In my researches on gadolinite and samarskite I have always attached great importance to the atomic weights. When the equivalent of a base is found to be higher than that of the other members of the same group (decipia and ytterbia, for instance) I have not had the least doubt of the specific existence of this base. But if this equivalent, on the contrary, should be intermediate between two others (philippia as compared with yttria and terbia), I naturally have multiplied experiments to make certain that I am not working with a mixture of known bodies. In this case the physical characteristics have sometimes been of great help. For these reasons, therefore, ytterbia, decipia, and philippia appear to me definitely acquired for science.

Scandium is unknown to me; I can say nothing about it.

Nothing has taken place to make me change my opinion upon mosandrium since I proposed to erase it from the list of elements.

Samarium.—M. Lecoq published in February and August, 1879, two notes, one on a new earth obtained from samarskite and the other on samarium. The properties which he attributes to his unnamed earth do not appear to me to differ essentially from those of decipia, or rather to a mixture of decipia and terbia: samarium is only characterised by absorption rays which appear to embrace a portion of those of decipium. I do not know any facts which would lead me to imagine that decipium is not homogeneous; its absorption rays increase and diminish together in all the treatments to which I have submitted it. The discovery of samarium therefore demands verification by further experiments.

MM. Marignac and Soret have shown that Bunsen's erbia is a mixture of several bodies. With the assistance of M. Thalén, M. Clève has repeated their experiments with the same results. But the *savant* of Upsala has gone further than those of Geneva; he does not hesitate to give names to the supposed new metals which he believes to be the cause of certain spectroscopic differences. According to him the ultra-red ray discovered by M. Soret characterises thulium; the red and green rays ($\lambda=640$ and 536) belong to holmium,† whose oxide is yellow and the nitrate less easily decomposed by heat than that of erbium; beyond this he has neither obtained the first nor the second in a state of even approximate purity.

Samarskite contains very little of the old erbia of Bunsen: the absorption spectrum of this latter is very feeble with the solutions obtained from it, and in particular the green and blue bands ($\lambda=523$ and 488) of erbia (in a restricted sense) are feeble; on the contrary, the indigo band ($\lambda=462$) shows much better. After having separated the didymia, decipia, and almost all of the terbia, I submitted the formiate of the earths to fractional crystallisation; the first products gave from 49 to 47 per cent of

* Not having been for some time in a position to see the *Comptes Rendus* I only know some of the notes on these new metals from what has appeared in the Chemical News of London. If, therefore, there is some misunderstanding on my part it must be attributed to a want of sufficient information.

† M. Soret likewise adds the indigo band, $\lambda=432$.

base. They were re-united and re-crystallised several times. In this way was separated a salt rich in terbia and mother-liquors richer in yttria: these were rejected. The rest, calcined and combined with nitric acid, showed the indigo band very strong, and the others more feeble. This nitrate, dissolved or in crystals, was perfectly colourless; its base, of a beautiful clear yellow, had the equivalent 98 ($y_0 = 74$, $\pi_0 =$ about 115). This was submitted to a series of partial decompositions by heat, which divided it into six products (A to F). The earth from the first, slightly clearer, had the equivalent 102; the crystals of its formiate were slightly rose-coloured; its absorption spectrum showed the absorption rays of erbia (in a restricted sense), but deeper. The four products following (B to E) contained a more coloured base; its nitrate, which was colourless, gave a spectrum consisting only of the red (640) and the green (536) rays, narrow, but much stronger than before, and of the large indigo band (448 to 455). The green ray of true erbia was reduced to a narrow trace; the blue had disappeared. These earths, B to E, could not be split up into yttria and terbia by any known means. Finally, the product F gave a feeble spectrum; its colouration and its atomic weight were less than those of the original mixture.

I have called philippia the yellow oxide, distinct from terbia, which forms the bulk of the earths of which I have just spoken. Its properties are those of the earth X of M. Soret and of M. Clève's holmia: this last named, being a duplicate, should not be retained.

In strictness it may be supposed that philippia is a mixture of two oxides, one of which gives the indigo band (448 to 455), and the other the rays 640 and 536; but I know of no fact in favour of such a conclusion.

The so-called euxènite from North Carolina contains still less of the earths giving absorption spectra than samarskite—a trace only. Besides a notable proportion of terbia I have obtained from it a straw-yellow earth, with an equivalent ranging about 90, without absorption spectrum, and which does not appear to be a mixture of terbia and yttria. I am not yet sure whether samarskite contains it, and in particular whether my philippia may be soiled by it: this is a point which I hope to clear up very soon. I am also examining another base from samarskite which appears to have a great resemblance to ytterbia.—*Comptes Rendus.*

PRODUCTS OF THE SLOW OXIDATION OF PHOSPHORUS.

By R. H. RIDOUT.

READING Professor McLeod's paper in the *Journa of the Chemical Society* for this month recalls some experiments I instituted as far back as 1874 or 1875, which point to the same conclusions, though the examination was undertaken with a different object. A country medical practitioner had under his care a very obstinate case of fistula, and conferred with a London specialist, who recommended an injection of "ozonised water." In vain did the medical man apply to successive wholesale chemists for this article. He then came to me, asking if I could prepare some. I told him that it was the general opinion that ozone was insoluble in water, but to make sure of the matter I instituted some experiments, and among others the preparation of ozone by moist phosphorus. A glass cylinder was fitted with a cork, having suspended from its centre a bracket containing lumps of phosphorus (about ¼ lb.), and was perforated with four holes. Through one passed a short tube bent at a right angle, and leading to the aspirator; through the second a tube terminating in a fine jet, and delivering water at a temperature of 20° to 22° C. on the phosphorus; through the third passed a Wirtemberg syphon, to remove the superfluous water and prevent the cylinder from filling; and through the fourth a tube leading nearly to the surface of the water. On aspirating a current of air (20 litres per hour) an abundant evolution of an oxidising body ensued. The air was passed in its way to the aspirator through a wash-bottle containing water, but as this did not suffice to remove the phophorus fumes it was led through two wash-bottles containing caustic soda, and then through recently distilled water. The oxidising body passed without loss through the caustic soda, and not a trace of any oxidising agent could be detected in the distilled water, after the action had been going on for six hours. It thus appeared that the body was insoluble in water, and not attacked by the caustic alkali. It could not therefore be peroxide of hydrogen, which is soluble in water, and would have been destroyed by the carbonate contained in the commercial soda used. Further, it appears to confirm what has so often been said before, that ozone is insoluble in water. Upon my client sending to the specialist for a sample of the "ozonised water," it turned out to be potash permanganate. Doubtless by this time the label bearing this name has become quite familiar.

THE RESULTS OF SEWAGE TREATMENT.

IN a recent issue we laid before our readers the able report on the efficacy of different methods of sewage-treatment as presented to the Local Government Board by Dr. Angus Smith, F.R.S. Both to municipal authorities and to the public at large it must be very satisfactory that this vexed question should have been finally dealt with by an authority whose competence and freedom from bias are alike beyond suspicion. There are in the report certain points of interest to which we beg to call especial attention. Five processes have here been specially selected: irrigation, pure and simple, as carried on at Aldershot; precipitation by lime, as conducted at Burnley (Scott's process), and again at Birmingham; precipitation by aluminous salts in conjunction with clay and charcoal (A B C process), as in action at Aylesbury; and finally, treatment with sulphate of alumina and lime, followed up by irrigation, as at Coventry. We think it may reasonably be inferred that these five processes have been selected not at random, but as the most successful. Had any other method now in operation in England been found superior, or even equal, as a means of purifying polluted waters, Dr. Smith would assuredly not have concealed a fact of such importance. The difficulty which municipal authorities have hitherto experienced in making a selection will in future be greatly reduced.

Aldershot may, we suppose, be fairly taken as a type of the irrigation-system, where carefully worked upon a suitable soil. That under such circumstances it is highly successful, as far as the purification of the sewage is concerned, cannot be denied. But this efficiency is greatly modified by the season, since in dry weather the Aldershot effluent takes the first rank with a proportion of only 0·0550 part of albuminoid ammonia for 100,000, whilst in wet weather this impurity rises to 0·207.

As regards the precipitation-processes the results of the lime-methods are much less striking. The Burnley effluent retains 0·305 part of albuminoid ammonia per 100,000, or 25·4 per cent of the proportion originally present. At Birmingham the albuminoid ammonia left in the purified water rises to 0·66, or 62·9 per cent of the original quantity. Sulphate of alumina is more efficacious.

The Aylesbury effluent (A B C process) retains only 0·070 per 100,000 of albuminoid ammonia (=0·0490 per gallon), or 10·6 per cent of this impurity as existing in the sewage. It will be noticed how decidedly this falls within the limit (0·121 part per gallon) proposed by the late Rivers' Pollution Commission. This process is therefore not merely

superior to the lime treatments, but in wet weather to irrigation. These results strongly confirm the opinion expressed some years ago by the Editor of this Journal, that the purification of sewage must turn to a great degree upon the price of the soluble salts of alumina.

It will readily be admitted that if, *e.g.*, the Aylesbury effluent were subsequently passed through land, it would be still further purified. We need therefore feel no surprise that the water at Coventry, where a double system prevails, should be of a very high quality. The sewage of that town, which is first treated with sulphate of alumina and lime and then run upon the soil, retains, as it finally issues into the river, only 0·061 of albuminoid ammonia per 100,000, or 3·60 per cent of its original proportion. Irrigation after the use of lime, however, gives less striking results. Sewage thus dealt with at Birmingham still retains 0·210 of albuminoid ammonia, or 20 per cent of the initial quantity.

It must not be forgotten that four other samples of effluents taken at Aylesbury—on July 23rd, 26th, and 29th, and September 4th—were all superior in purity to the one above mentioned: that taken on September 4th containing merely 0·035 of albuminoid ammonia for 100,000, or 0·024 per gallon. We fear that many waters more heavily charged with organic pollution are used for household consumption.

Dr. Angus Smith's results certainly prove that sewage is the most completely purified by irrigation if all the circumstances are favourable, *i.e.*, if the soil is of a suitable nature and the weather is dry. Where these conditions are wanting it is excelled by a judicious application of aluminous or alumino-ferric salts. These conclusions agree substantially with the results of our own experience. We have always contended that no one process could at all places and under all circumstances claim the preference. Where suitable land can be procured near the point where the sewage has to be discharged, and especially where the climate is dry, we have fully recognised the value of irrigation. But in the numerous cases where the conditions are the reverse, we hold that a judicious system of precipitation is the only practical expedient.

RESEARCHES ON COBALT AND NICKEL, AND A METHOD FOR THEIR DISTINCTION IN MIXED SOLUTION.

By Dr. G. PAPASOGLI.

If a strip of zinc is plunged in a solution of the double cyanide of nickel and potassium, we observe suddenly, or in a short time, that it is covered with small bubbles which gradually increase and form a continuous gaseous envelope, whilst upon the zinc nickel is deposited in the state of a black powder, and around it there are produced dense clouds formed by an intensely red liquid.

This liquid is the solution of a new salt of nickel in potassium cyanide, having a greater density than the medium in which it is found, and descending to the bottom and slowly increasing it colours the whole mass of the liquid a blood-red.

On attentively observing the progress of the reaction it was seen that the colouration reached a maximum limit at which the double cyanide must have undergone a complete modification, but the compound which is formed becomes modified in its turn, since the colouration slowly decreases in intensity and finally disappears altogether. The author considers that in this experiment the red colour which is developed depends on a new combination of cyanogen and nickel produced by the reduction which the cyanogen undergoes from the action of the nascent hydrogen evolved when a small particle of the metal is deposited upon the slip of zinc. This opinion is confirmed by the following experiment:—On causing a solution of the double cyanide of nickel and zinc to be traversed by an electric current, and having care to keep the two platinum rheophores separate, so as to observe separately the action of the oxygen and the hydrogen, there was observed at the negative pole where hydrogen was evolved a reddish colouration, more or less intense according to the quantity of nickel present, whilst at the positive pole there was no colouration. This experiment shows that the zinc takes no part in the reaction, but is merely a means of evolving hydrogen. The same result is obtained if aluminium is applied in place of zinc.

If the experiment which has been made with the double cyanide of nickel and potassium is repeated with a double cobaltic cyanide, it is seen easily that the reaction above mentioned is peculiar to the former metal.

If a slip of zinc is immersed in a solution of the double cyanide of cobalt and potassium the metal becomes covered with a black powder and a gaseous envelope, but there is not the slightest colouration. If such a solution is traversed by an electric current it remains colourless at the negative (Zn) pole, but assumes a maroon colouration at the positive (Cu), due probably to para-cyanogen mixed with an oxide of cobalt.

The author next sought to ascertain if the presence of cobalt injures the reaction, preventing it altogether or rendering it less sensitive. He finds that it is totally unaffected, and that on experimenting either with the slip of zinc or with the electric current it is possible to detect 0·0005 of nickel mixed with an excess of cobalt. In such delicate researches it is necessary to operate upon very concentrated solutions.

There is no want of characteristic reactions for the detection of cobalt and nickel when they are separate from each other, and which permit to recognise cobalt when mixed in all proportions with nickel. But it is not so when a small quantity of nickel is mixed with cobalt, in which case it has been difficult to establish its presence.

Although nickel when alone displays very salient characteristics, they are all masked by the presence of cobalt.

In a note on the alkaline polysulphides as reagents for cobalt, the author made known that on treating a solution of the double cyanide of cobalt and potassium with any of these polysulphides there is produced an intense red colouration, peculiar to cobalt, upon which the simultaneous presence of nickel has no appreciable influence.

The author proposes the following method, based upon these two reactions, for the recognition of cobalt and nickel:—

To an acid solution of the two metals is added a slight excess of a solution of the hydrate of potassium, to precipitate the metals in the state of basic salts. The precipitate is allowed to settle, the alkaline liquid decanted off, and the deposit repeatedly washed to remove the excess of potassa. A few drops of ammonium chloride and of ammonia are then added, and it is heated in a slight excess of potassium cyanide.

Care must be taken, as far as possible, not to stir the solution of the double cyanide, to prevent the absorption of atmospheric oxygen. If the double cobalt solution is converted into cobalti-cyanide, the addition of an alkaline polysulphide no longer produces the red colouration mentioned above.

The solution of the cyanides is then divided into two portions. To the first are added a few drops of the ammonium polysulphide, so that it may form a stratum above the cyanide solution. If in the plane of contact of the two liquids there is observed a red colouration, this indicates the presence of cobalt. The reaction is independent of the presence of nickel, and is sensitive to the fourth and even the fifth decimal place if only the solution is highly concentrated.

In the other portion of the solution is immersed a small slip of zinc: if the liquid contains nickel there will be observed, besides the gaseous envelope, an intense red colouration which shows itself over the whole surface of

the slip, but especially at the lower part. The presence of cobalt does not interfere with this reaction, which is still produced even if the solution containing the cobalt has absorbed oxygen.

If the solution is concentrated the sensitiveness of the reaction extends to the fourth decimal place. The presence of ammoniacal salts in excess retards, or even hinders, the reaction.

The solution of potassium cyanide used should be concentrated, but an excess in quantity should be avoided, especially if the quantity of nickel is small. If an excess of the cyanide is used, then, on immersing the slip of zinc, there occurs suddenly a strong evolution of gas, which disperses the red colouration and makes it difficult to perceive the reaction.

To avoid this inconvenience the author places in the solution to be examined a slip of platinum, joined at one extremity to a slip of zinc. The greater portion of the gas then envelopes the platinum, and as the red colour forms only around the zinc it is less readily dispersed, and the reaction remains more sensitive.—*Gazzetta Chimica Italiana.*

ON THE PHYSICAL CONSTANTS OF LIQUID HYDROCHLORIC ACID.*

By GERRARD ANSDELL, F.C.S.
Chemical Assistant at the Royal Institution.

In a paper read before the Royal Society, on June 18th, 1879, I described the results of some experiments made with liquid acetylene, obtained by compressing the gas in one of M. Cailletet's ingenious pumps for the liquefaction of gases. The tensions of the saturated vapour then obtained were so entirely different from M. Cailletet's results, that it appeared to me to be possibly due to a slight impurity in the gas, probably a trace of mono-bromethylene which always occurs in the red copper compound of acetylene, and is very difficult to completely eliminate.

I therefore prepared a quantity of the silver compound (which can be obtained entirely free from mono-bromethylene) by passing acetylene prepared in the same way as formerly, viz., by the action of alcoholic potash on di-bromethylene, into an ammoniacal solution of nitrate of silver.

On filling several tubes with acetylene generated by the action of hydrochloric acid on this compound, the tensions were found to be exactly the same as those obtained with the acetylene made from the copper compound, thus proving the correctness of the former experiments.

As the Cailletet pump is so well adapted to the examination of gases in their liquid state, and is at the same time so easily managed, it appeared interesting to determine the physical constants of some other gases, and Prof. Dewar suggested an examination of the halogen acids, with regard to their physical relations to each other, more especially as we have absolutely no reliable knowledge as to these numbers.

Faraday was the first to liquefy hydrochloric acid gas in 1823, and he subsequently, in 1848, made a series of determinations of the vapour tensions of the liquid at different temperatures. He also liquefied hydrobromic and hydriodic acids, but gives no account of their properties in a liquid state. Gore (*Proc. Roy. Soc.*, vol. xiv.) examined very carefully the chemical properties of liquid hydrochloric acid, its solvent action, &c., but made no determinations of its physical constants.

Hydrochloric acid is the only one I have as yet had time to examine, with the following results :—

The gas was made by the action of strong sulphuric acid on dry chloride of ammonium, being afterwards freed from sulphuric acid and dried before entering the tubes. It was found of no advantage to continue the stream of gas for more than six hours, as a constant minimum of air always remained in the tube at the end of this time (about 1-400th of the total volume of the tube), which appeared utterly impossible to remove.

The pump was used in the same way as described in my former paper, two iron reservoirs being used, one containing the air manometer, and the other the tube with the gas to be liquefied.

Apart from the mere determination of the vapour-tensions, densities, &c., the ratios of the volume of saturated vapour to that of the liquid was considered of the highest importance, as from these numbers the latent heat of transformation and other important data can be easily calculated. For these reasons the gas was examined in rather a different way to the acetylene, the volume to which it had been compressed at the point of liquefaction (or the volume of the saturated vapour) at any given temperature being first accurately determined, and then the pressure increased until the condensed liquid entirely filled the upper part of the tube. The volume of this liquid column was then measured, so that a comparison between the volume of the saturated vapour and the volume of the total condensed liquid was obtained at each temperature.

This fractional volume of the gas at the point of liquefaction was determined by observing when the air manometer ceased to show an increase of pressure on compressing the gas; the volume of the gas at this point being then measured, and the pressure being then gradually released until the air manometer showed a slight decrease of pressure—the volume of the gas was then again measured at this point, and the mean taken as the point of liquefaction.

The results of the whole series of experiments are recorded in a condensed form in the following table :—

A.	B.	C.	D.	E.	F.
4	137·31	$\frac{1}{38·89}$	7·55	18·18	29·8
9·25	118·96	$\frac{1}{45·75}$	7·90	15·05	33·9
13·8	103·50	$\frac{1}{53·19}$	8·35	12·39	37·75
18·1	91·77	$\frac{1}{61·17}$	8·74	10·50	41·80
22·0	81·19	$\frac{1}{70·06}$	9·10	8·92	45·75
26·75	69·69	$\frac{1}{82·94}$	9·50	7·33	51·00
33·4	55·75	$\frac{1}{105·98}$	10·12	5·50	58 85
39·4	44·85	$\frac{1}{134·33}$	10·68	4 19	66·95
44·8	36·34	$\frac{1}{168 67}$	11·96	3·03	75·20
48·0	31·33	$\frac{1}{197·60}$	12·00	2·61	80·80
49·4	27·64	$\frac{1}{224·96}$	12·92	2·13	84·75
50·56	25·70	—	14·30	1·79	85·33
51·00	23·96				

In this table—

A = temperature of gas.

B = volume of the saturated vapour at point of liquefaction.

C = fractional volume of the gas at point of liquefaction in relation to the initial volume under one atmosphere of pressure.

* Read before the Royal Society, January, 1880.

D = volume of the condensed liquid.
E = ratio of volume of liquid to that of the gas.
F = pressure in atmosphere.

The critical point was found to be 51·25° C.

It will be seen from this table that the volumes of the saturated vapours and liquid gradually approach each other as the temperature nears the critical point, and would undoubtedly become identical, if the experiments could be carried on up to the critical point. Curves accompany the paper, the first of which represents the change of volume of the saturated vapour and liquid, in relation to the temperature; and the second the ratio between these volumes in relation to the temperature (column E in the table) show these results in a graphical form.

Curves.

The ratio between the volume of the saturated vapour and the volume of the liquid at different temperatures decreases very regularly until within about three degrees of the critical point, where a singular point in the curve occurs, and the ratio approaches unity with great rapidity. The volume of the liquid increases very regularly up to a temperature of about 48° C., and at 51° C., or within 0·25 of a degree of the critical point, the distinction between the saturated vapour and the liquid vanishes, as although liquid is plainly seen to condense on the surface of the mercury, on increasing the pressure the line of demarcation immediately disappears, and it is impossible to say whether the tube is filled with the saturated vapour or the liquid itself; therefore no results could be obtained nearer the critical point than about a fourth of a degree.

Avenarius, in a paper entitled "The Causes which Determine the Critical Point" (Acad. Sci., St. Petersbourg, 1876-77), made a number of experiments on ether, and came to the conclusion that the volumes of the saturated vapour and of the condensed liquid at the critical point were not identical. He was under the disadvantage of working at a very high temperature, the critical point of ether being 192·6° C., which must have been very difficult to keep fixed within half a degree.

My own experiments, which were carried out at a very much lower temperature, and were consequently capable of greater accuracy, on account of the facility with which the temperature could be kept constant to within 1-20th of a degree, appear to confirm his results, in so far as it is evidently impossible to measure the relative volume of fluid and gas within less than a fourth of a degree of the critical point, and at this place the volumes are certainly unequal. This, however, does not disprove their identity as the critical point.

The density of the liquid at different temperatures was determined in the same way as described in my former paper, and gave the following numbers:—

Temperature.	Density.
0 ° C.	0·908
7·5	0·873
11·67	0·854
15·85	0·835
22·7	0·808
33·0	0·748
41·6	0·678
47·8	0·619

It has therefore not quite such a high density as liquid carbonic acid, which is 0·95 at 0° C., and is about twice as high as acetylene, which is 0·450 at the same temperature. It is interesting to note that acetylene is the lightest known fluid substance. On referring to the density of liquid hydrochloric acid given by other authors, Professors Roscoe and Schorlemmer, in their recent treatise on chemistry, describe it as a colourless liquid having a specific gravity of about 1·27°. As this value is so much higher than that obtained by myself, and as I feel confident of the accuracy of my results, it seems evident that a mistake has in some way arisen, and that the value given by them refers to the density of the gaseous acid with reference to air, and not to the liquefied gas. Unfortunately Faraday does not seem to have determined its density.

Experiments made to determine the coefficients of compressibility of the fluid at different temperatures were carried on in the same way as formerly detailed. The following are the chief results:—

Mean coefficients of compression at different temperatures. Range of pressure from 52·8 to 208 19 atmospheres.

Temperature of HCl.		Coefficients.
47·0 ° C.	=	0·00166
41·6	=	0·00123
33·0	=	0·00096
22·7	=	0·000635
15·85	=	0·00062
10·5	=	0·00054
5·7	=	0·000397

It is rather more compressible than liquid acetylene, whose mean coefficient at 22·3° C. is 0·00058.

The latent heat of hydrochloric acid and other values depending on thermo-dynamical considerations, will be given in a separate communication.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 5, 1880.

Mr. Warren De la Rue, President, in the Chair.

The following certificates were read for the first time:—M. Bechler, W. J. Dibdin, A. C. Fryer, C. C. Graham, C. P. Sheibner, J. R. Skelton.

The following communications were read:—

"*Note on the Assumed Formation of Ozone by the Atmospheric Oxidation of Phosphorus*," by C. T. Kingzett. The author criticised a short paper recently read before the Society by Prof. McLeod on the above subject. The quantitative experiments in Prof. McLeod's paper consisted in aspirating air over phosphorus partly submerged in water, and then heating the gas to a temperature at which peroxide of hydrogen is assumed to be decomposed into water and oxygen. Any water formed was absorbed in a weighed sulphuric acid tube. In one experiment 2760 c.c. of air thus treated increased the weight of the sulphuric acid tube 0·0006 grm., while the gas which passed through liberated iodine in a potassic iodide mixture equal to 1·8 c.c. of decinormal sodium thiosulphate. Prof. McLeod then proceeds:—"Now as 1 c.c. of the thiosulphate corresponds to 0·017 grm. of hydroxyl, which on decomposition by heat would form 0·009 grm. water, and as we may reasonably assume that at 200° at least the half of any hydroxyl that might be present would be decomposed, we should in the last experiment expect an increase of about 0·016 grm. in the sulphuric acid tube instead of only 0·0006 grm." Prof. McLeod therefore concludes that the active agent cannot be hydroxyl, and is consequently ozone. The author of the present paper contends that the above argument falls to the ground because 1 c.c. of decinormal thiosulphate is not equivalent to 0·017 grm. of hydroxyl, but only to 0·0017 grm.; so the gain in the sulphuric acid should be 0·0016 and not 0·016 grm. Passing exposure to 200° would probably not decompose a very small quantity of peroxide of hydrogen diffused through nearly 3 litres of air. The author, therefore, does not accept McLeod's experiments as in any sense conclusive, and hopes to present shortly a further communication on the subject.

The Secretary then read a paper, entitled, "*Contributions from the Laboratory of the University of Tôkio,*

Japan (II *On Persulpho-cyanate of Silver*)," by R. W. ATKINSON. In a previous paper (*Chem. Soc. Journ.*, ii., 1877, 254) the author proved the above salt to have the formula $Ag_2C_2N_2S_3$; also, that when boiled with water, this yellow salt was converted into a black precipitate, in which the ratio of silver to sulphur varied, the variation being at that time attributed to the presence of some silver sulphocyanate in the silver sulphide, which formed the main bulk of the substance. From further experiments the author concludes in the present paper that the body mixed with the sulphide is some undecomposed persulphocyanate. The reaction being—

$$2H_2C_2N_2S_3+4AgNO_3=(Ag_2C_2N_2S_3+Ag_2S)+C_2N_2S_2+4HNO_3.$$

The actual proportions of the two insoluble silver salts formed depends on the influence of time, temperature, and the quantity of free acid present. The author has not been able to isolate the cyanogen disulphide, but is at present examining the orange-red sublimate formed when dry silver persulphocyanate is heated, in the hope that it may contain the missing body. The paper contains several tables, giving the results of many experiments as to the influence of variations of time, temperature, and the quantity of the free acid present on the above decomposition.

On Methylated Dioxethylen-amines," by H. F. MORLEY. Wurtz showed that ethylene oxide unites directly with ammonia, forming mono-, di-, and tri-oxethylen-amine, and that by heating glycollic chlorhydrin, or ethylenic oxide, with a solution of trimethyl-amine, neurine chloride is obtained; Baeyer having proved neurine to be trimethyl-oxethylen-ammonium hydrate,—

$$C_2H_4\begin{matrix}N(CH_3)_2CH_3HO\\OH\end{matrix}.$$

Various similar compounds were subsequently prepared, but no one had investigated the action of mono- and di-methyl-amine on glycollic chlorhydrin. These reactions the author has studied in the present paper. He has prepared and analysed the platinum salts of mono- and di-methyl-di-oxethylen-amine. The first crystallises in orange-red prisms; the second separates in small yellow crystals.

"*Note on Igasurine*," by W. A. SHENSTONE. The author has prepared some so-called igasurine of Desnoix. Four gallons of an aqueous decoction of *nux vomica* beans, from which the alkaloids had been precipitated by boiling with lime, were evaporated; on examination, the residue contained notable quantities of strychnine and brucine, the quantity of strychnine present being sufficient to explain the superior activity of the so-called igasurine over that of brucine. The other property which was supposed to distinguish it from brucine, viz., its superior solubility, being of little importance, as the solubility of brucine varies with its purity. Igasurine is therefore a mixture of brucine and strychnine.

Mr. HOWARD and Dr. WRIGHT commented on the utter uselessness of the solubility of an alkaloid as a test of its nature, unless the alkaloid was perfectly pure.

Prof. TIDY remarked that there was a marked difference between the physiological action of igasurine and strychnine.

"*On some Reactions of Tertiary Isobutylic Iodide*," by L. DOBBIN. Primary isobutylic iodide, prepared in the usual way from the corresponding alcohol, was allowed to flow from a dropping funnel into a boiling alcoholic solution of potassic hydrate; isobutylene was formed and collected in a gas-holder. The isobutylene was then shaken vigorously with fuming solution of hydriodic acid, the mixture being iced. The product thus obtained was separated from the aqueous hydriodic acid solution, treated with dilute potassic hydrate, dried with calcic chloride, and filtered. On prolonged shaking with a 12 per cent solution of hydrocyanic acid tertiary isobutylic iodide dissolves. After treatment with zincic oxide and distillation some quantity of trimethyl carbinol was obtained in crystalline masses melting at 25·5°, boiling at 82° C. A combustion was made, and numbers obtained closely agreeing with those calculated. It was afterwards found that the hydrocyanic acid takes no part in the reaction, which occurs equally well when water alone is used. This furnishes the first example of an alcohol radical being decomposed by water at ordinary temperatures. On mixing tertiary isobutylic iodide with the quantity of zinc oxide necessary to combine with the iodine present, the temperature being kept at about 15° C., isotributylene was formed, and identified by its vapour-density, analysis, &c.,—

$$6\begin{matrix}CH_3\\CH_3\end{matrix}\!\!>\!C(CH_3)\!-\!I+3ZnO=2C_{12}H_{24}+3H_2O+3ZnI_2.$$

Lermontoff also prepared the substance (*Liebig's Annalen*, 196, 116) by the action of calcic oxide, at 100° C. in sealed tubes, on tertiary isobutylic iodide saturated with isobutylene; she found it, however, to be mixed with isodibutylene, and gives no quantitative results. The author of the present paper obtained no sensible quantity of isodibutylene, and the reaction was effected at the ordinary temperature. Wislicenus observed that when tertiary isobutylic iodide was acted on by sodium a considerable quantity of gas was formed. The author has studied this reaction, and analysed the gas which was obtained mixed with atmospheric air. 630·6 c.c. were obtained by the action of 1 grm. of sodium. The gas contained:— C_4H_8, 16·5 per cent; C_4H_{10}, 1·14 per cent; H_2, 18·07 per cent. The formation of hydrogen is explained by the polymerisation of some of the isobutylene. Thus, by decomposing tertiary isobutylic iodide by sodium, the bodies formed are isobutylene, isotributylene, and hydrogen, with small quantities of a hydrocarbon not absorbed by fuming sulphuric acid. No isodibutylene was found.

Mr. M. W. WILLIAMS suggested that the action of dry hydriodic acid on the dry gas should be investigated: as the author had shown that water decomposed the iodide, the hydrogen might be formed by the action of sodium on the products of decomposition of the iodide by water.

The Society then adjourned to February 19, when a ballot for the election of Fellows will be held.

PHYSICAL SOCIETY.

THE annual Conversazione of this Society was held on Saturday evening, February 7, in King's College. The Museum of King George III., the Wheatstone Laboratory, and other halls of the College were occupied by a fine display of physical apparatus and artistic furniture, including numerous relics of Sir Charles Wheatstone. There was a large number of ladies and gentlemen present, and during the evening selections of music were played by the Musical Association of the Royal School of Mines. The apparatus was peculiar to the whole range of physical science, and were furnished in part by the College and in part by the various instrument makers and electric engineers of the metropolis. Mr. Crookes exhibited his experiments, and delivered a short lecture on *Radiant Matter*. The Telephone Company and the British Electric Light Company contributed telephones and electric lamps, and Herr Faber exhibited his ingenious speaking machine.

Detection of Oleo-Margarin in Butter.—The author remarks that since it has been found practicable, by the use of lard oil to lower the melting-point of margarin, the determination of the melting-point of butter, or of the fatty acids which result from its saponification, is no longer sufficient for the detection of sophisticated butters. It is only by determining the fatty acids, soluble or insoluble, in water that the fraud can be detected.—*Les Mondes.*

CORRESPONDENCE.

NITROUS COMPOUNDS IN SULPHURIC ACID.

To the Editor of the Chemical News.

SIR,—In a paper which Mr. Mactear read some time ago to the Newcastle Chemical Society, and which has been republished in your last few numbers, that gentleman attacks some of my previous statements on the estimation of nitrous and nitric acids. As since that time a good deal more has been published on this subject, and as the same is fully discussed in various parts of my "Treatise on the Manufacture of Sulphuric Acid and Alkali," I refrain from requesting you to publish my reply to Mr. Mactear, which was read to the Newcastle Chemical Society on November 28, 1878, and is printed in its *Proceedings*, vol. iv., pp. 177—184. I shall only solicit your permission to mention, as briefly as possible, the more important heads of my reply.

First. I pointed out that some of the objections made against my statements arose from mere misunderstandings. My analytical processes having been worked out to assist me in the theoretical study of the action of SO_2 on nitrosulphonic acid, they are not affected by the impurities existing in factory acids.

Secondly. I never thought of condemning the estimation of nitric acid by reduction to ammonia *on principle*, but I pointed out that this process sometimes yielded bad results, even when all the prescriptions given for it up to that time were strictly observed, and that, therefore, other processes of undoubted accuracy should be preferred to it. Possibly Mr. Mactear's own modification might be reliable, but of that I could know nothing then. Curiously enough, Mr. Mactear quotes Dr. Eder as confirming the accuracy of the reduction process, whilst that chemist most decidedly proves that this process, in *all* the shapes published up to that time, cannot be depended upon. Only for his modification he claims perfect accuracy, and this I had been able to confirm some time before I knew of Mr. Mactear's paper; but that does not touch my assertion respecting the *former* processes. Still I maintained (and to this I adhere now as well) that the reduction processes for estimating acids are not to be recommended for nitrous vitriol and similar compounds, because they require a good deal of apparatus and very much time; whilst the permanganate process, combined with the ferrous sulphate process, or Crum's mercury method, fulfils all requirements for pure acids, and the latter even for impure ones at a mere fraction of the time.

Mr. Mactear condemns the analytical method I employed for estimating both nitrous and nitric acids at the same time as "quite absurd" because the blank experiment required 1 per cent of permanganate in excess. That expression was really not called for: the "1 per cent" excess over the theoretical quantity means 0·15 c.c., which I stated would be required for staining the large bulk of liquid, and which anyhow would only amount to 0·0013 m.grm. of N_2O_3 on a total of about 50 grms. of vitriol! No other analytical process could have estimated such a small quantity with certainty.

Touching arsenious acid, I merely claimed that its interference is of very slight amount, even in ordinary nitrous vitriol, and this is proved by many experiments I made on purpose.

Mr. Mactear calls it "quite incomprehensible that I should have forgotten the fact that N_2O_5 is formed from the decomposition of N_2O_4 in the presence of water." That would have been very careless indeed on my part, but I cannot comprehend that he did not recognise N_2O_4 to be a misprint for N_2O_3. This is so fully proved, both by the context and by my *previous* publications on the subject, that I need not stop to argue the point. After Winkler, who first discovered the facts, nobody has shown more conclusively than myself that under the circumstances in question only N_2O_3 (*not* N_2O_4) is formed, viz., by the action of an excess of oxygen on NO *in the presence of sulphuric acid*.

Mr. Mactear disagrees from my opinion that in *normal* nitrous vitriol nitric acid does not occur, but merely N_2O_3. Apart from my other reasons, all founded upon experimental evidence, I showed in my reply that even in a case quoted by Mr. Mactear, where he had purposely produced quite *anomalous* conditions in an acid chamber, conducive to the formation of N_2O_4, and consequently of NO_3H in the Gay-Lussac acid, only 5·92 per cent of the nitrogen in the latter was found to exist as nitric acid.

As I have no wish to be drawn into a fresh controversy on a subject which may now be called well worn, I have purposely remained entirely on the defensive, and merely shown that I did not say the things attributed to me. My positive arguments can be found in my pretty numerous publications on that subject, both English and German, and in a condensed form in my "Treatise."—I am, &c.,

GEORGE LUNGE.

Polytechnical School, Zurich,
January 29, 1880.

COMPOSITION OF WELDON MUD.

To the Editor of the Chemical News.

SIR,—Mr. J. E. Davis wonders why the reproduction of a paper on this subject by T. Post, in the *Transactions of the Society for the Promotion of Industry* (of Berlin), should be prohibited. I really do not know myself why this very unusual prohibition was laid down in that special case; but in any case it only refers to a *literal* reproduction, not to abstracts nor to translations; and the whole substance of the paper was given by Post, in June and July last, in the *Berliner Berichte*, of course without any reservation as to reproduction. A refutation of some important points in that paper, which has been read before the Newcastle Chemical Society, will no doubt be noticed shortly in the CHEMICAL NEWS.—I am, &c.,

GEORGE LUNGE.

Zurich, February 9, 1880.

CUPRIC TEST-PELLETS FOR SUGAR.

To the Editor of the Chemical News.

SIR,—The idea of giving to the chemist a reliable sugar-test that would keep any length of time is not a new one, and has been some years ago realised by Schiff (*Annalen der Chemie und Pharmacie*, Band 112, p. 369), viz., 250·0 of sulphate of copper in crystals are dissolved in a little warm water, and mixed with a solution of 280·0 tartrated soda. The light blue salt which separates is washed and dried at ordinary temperature; its formula is $C_4H_2O_5,CuO+3HO$, and it contains 29·964 per cent of oxide of copper. If well washed until the wash-water ceases to give a reaction with chloride of barium, 3·686 of it are reduced by 0·5 glucose: this quantity, after having been verified by titration, is filled into small glass tubes, stoppered, and kept standing in a box protected from daylight. When required for use the contents of one tube are dissolved in sufficient soda-lye of 1·14 sp. gr.—I am, &c.,

H. W. LANGBECK.

London, February 9, 1880.

ALCOHOL TABLES.

To the Editor of the Chemical News.

SIR,—In the last number of the CHEMICAL NEWS (vol. xli., p. 70) Mr. Allen has given a formula for obtaining percentage by volume of alcohol for a given percentage of proof spirit, as preferable to mine, designating it as

"clumsy." But his formula, which I notice for the first time, is, as it stands, certainly not correct. Say, for instance, How much is 95·1 percentage by volume, percentage of proof spirit? By his formula $P = V \times 1{\cdot}7525$ would give 166·6, which is wrong. Again, How much is 20 percentage of proof, percentage by volume? By his formula $V = P \times 0{\cdot}5706$ would give 11·46, which figure is, I suppose, intended to be deducted from the factor 57·06 = 45·6, which in this case brings it to my formula; therefore is not my formula at any rate the more concise? Surely it needs not the ability of a Cambridge Wrangler to decide.

As for the standard figure for proof spirit, 57·27, sp. gr. 0·9186, I quote—"By parliamentary enactment the strength of proof spirit has been fixed at such a density that 13 volumes at 51° F. should equal in weight 12 vols. of water at the same temperature. According to this standard proof spirit has a gravity of 0·9186 at 60° F., and contains 57·27 per cent by volume, or 49·5 by weight of absolute alcohol."

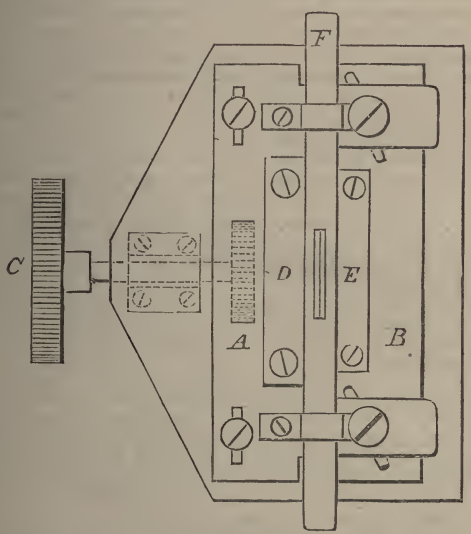
The object of my communication (Chemical News, vol. xli., p. 57) was merely intended to call attention to the utility of a set of tables for practical use, without any pretension of setting out the best or any particular formula.—I am, &c.,

S. Cohné.

SLIT FOR SPECTROSCOPE.

To the Editor of the Chemical News.

Sir,—I send a sketch of a spectroscope slit which, I think, has advantages over those ordinarily used. There is no fine screw which suffers generally from acid fumes; it occupies little room; and is, I think, easier to construct.



A is moved vertically by a rack; this displaces B sideways, both being guided by slots. D and E are movable iridium jaws; F a shutter for taking coincident spectra.—I am, &c.,

Alex. E. Tucker, Fell. Inst. Chem.

Rhymney Iron Works, Rhymney,
February 5, 1880.

Quinine Salts.—We are informed that Messrs. Domeier and Co. have been appointed agents of Messrs. C. F. Boehringer and Soehne, Mannheim, for the sale of their sulphate of quinine, quinidine, cinchonidine, cinchonin, and all other salts of quinine and santonine.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 3, January 19, 1880.

Heat of Formation of Chloral Hydrate.—M. Berthelot.—The author gives a detailed and illustrated description of the apparatus used in his experiments, and considers it proved that gaseous chloral and gaseous water combine with the disengagement of heat, forming gaseous chloral hydrate.

Chloral Hydrate.—A. Wurtz.—The author, after hearing the description of M. Berthelot's experiments, declares that the apparatus realises the same conditions which were observed in his own experiments. He points out that chloral contains always a small quantity of hydrochloric acid, which requires special precautions. He has never observed in his experiments the smallest elevation of temperature.

Plants which Serve as the Basis of the Different Curares.—G. Planchon.—All the plants which serve as the basis of the American poison belong to the genus *Strychnos*. There are four distinct regions in which the poison is prepared, and in each, distinct species of plants are employed. In British Guyana the chief species is *S. toxifera*, accompanied by *S. Schomburgkii* and *S. cogens*; on the upper Amazon the main material is *S. Castelnœana*, along with a menispermaceous plant. On the Rio Negro the chief ingredient is *S. Gubleri*, and in upper French Guyana the poison is chiefly composed of *S. Crevauxii*.

Remarks on the Use of Smithson's Battery for the Detection of Mercury, especially in Mineral Waters.—J. Lefort.—The gold-tin element proposed by Smithson for the detection of traces of mercury has been subjected by Orfila to a criticism, which is only in part well founded. If the apparatus is left for a considerable time in a liquid supposed to be mercurial, a small quantity of tin may dissolve and be deposited upon the leaf of gold, so that it is turned white even in the absence of mercury. So far, therefore, the experiment may lead to a doubtful or erroneous result, but as tin is not volatile it is merely requisite to heat the slip of gold in a narrow tube, in order to drive away the adhering deposit, and then to act upon the metallic sublimate with vapour of iodine, thus forming mercuric iodide of a more or less decided red colour. If the mixture operated upon contains merely mercury, the operation thus described leaves no doubt as to the sensibility and the exactnes of the process. But here the trustworthiness of the Smithson battery ceases, as it does not confine its action to the reduction of mercurial salts. The search for mercury in mineral waters has permitted the author to observe that arsenious and arsenic acids are easily reduced by the Smithson battery. As metallic arsenic is volatile, like mercury, and forms with iodine a compound of a red colour, more or less comparable to that of mercuric iodide, it follows that these two elements may be respectively confounded, especially when the red sublimate is obtained only in microscopic quantities. Hence, it appears that the oxides of arsenic are readily decomposed by metals under the influence even of a very feeble electric current. Thus a slip of copper immersed in a solution containing 1-10oth of arsenic acid does not change its appearance, but if hydrochloric acid is added, and especially a little common salt, metallic arsenic is deposited upon the copper. This fact ought not be forgotten when the very general presence of mercury in mineral waters is admitted on the faith of imperfect analyses.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
No. 15, 1879.

A Synthesis of Anthracen.—C. Loring Jackson and J. Fleming White.—The authors consider it as proved by their synthesis that the two atoms of carbon in anthracen are connected with both benzol nuclei in the ortho position.

Preparation and Derivatives of Xylylic Acid.—E. Ador and F. Meier.—A description of the barium, calcium, ammonium, and silver salts, of xylilic acid chloride, amide, and anilide.

A Peculiar Formation of Tolan-tetra-chloride.—C. Liebermann and J. Homeyer.—The authors obtained this compound on passing chlorine gas into boiling toluol on a large scale. They have not yet been able to determine the conditions under which this formation takes place.

Determination of the Solubility of Certain Constituents of Tar.—G. v. Bechi.—The solvents employed are absolute alcohol and pure toluol. The solution apparatus employed is that of V. Meyer. The results are given in the form of a table.

Formula of Quinhydron.—R. Nietzki.—The author upholds the accuracy of the formula $C_{12}H_{10}O_4$ in opposition to Wichelhaus.

Nitro-benzoic Acids of Fittica.—C. Bodewig.—A series of crystallographic determinations, for the details of which the reader is referred to Groth's *Zeitschrift für Crystallographie*, iv., part 1.

Synthesis of Substituted Guanidins.—E. Erlenmeyer. The author points out that he has for some years been engaged with researches similar to those lately taken in hand by F. Berger (*Berichte*, xii., p. 1859).

On Skatol.—L. Brieger.—The author assigns to skatol, which he has obtained from human excrement, the formula $C_{10}H_{10}N$, or $C_{10}H_{11}N$. He has determined its melting-point and vapour density, and studied its physiological action. It appears to be less active as a poison than phenol.

Studies on Compounds from Animal Tar.—H. Weidel.—This long and important memoir does not admit of abstraction.

No. 16.

Allotropic Conditions of Hydrogen.—Julius Thomsen.—Referring to the statement of Dr. D. Tommasi (*Les Mondes*, xlviii., No. 7), that "the formation-heat of potassium chlorate is 9760 cal.; that of potassium chloride, 104476 cal.; during the conversion of chlorate into chloride there is consequently an absorption of heat corresponding to the difference of the formation-heat of these two compounds, 104476 − 9760 = 94716, *i.e.*, this quantity of heat must be supplied in order to reduce the chlorate to chloride." These statements contain a threefold error. In the first place, according to the above data, the reduction of potassium chlorate to potassium chloride and oxygen would not absorb, but liberate, 94716 cal. Secondly, the figure 9760 is not the formation-heat of potassium chlorate, which amounts to 95840 cal., but the heat liberated on resolving this salt into potassium chloride and oxygen in the dry way. Thirdly, the reductions which Dr. Tommasi treats of refer to potassium chlorate dissolved in water, the liberation of heat on the decomposition of this salt in the moist way being 15370 cal. The theoretical considerations which Dr. Tommasi founds upon his figures lose, consequently, their value.

Formation of Glycosides of Several Members.—Hugo Schiff.—A notice of certain derivatives of helicin.

Thermo-chemical Researches on the Carbonates.—Julius Thomsen.—The author gives a table of the formation-heat of the anhydrous carbonates of potassium, sodium, barium, strontium, calcium, manganese, cadmium, lead, and silver as formed from metal, oxygen, and carbonic oxide. The formation-heats of the carbonates of barium, strontium, calcium, lead, and silver are also given when these compounds are generated by the union of carbonic acid with the metallic oxide. The quantity of heat absorbed during the decomposition of limestone in the kiln is 425 cal.

On some Derivatives of Resorcin and Orcin.—V. Merz and G. Zetter.—The authors describe the formation and properties of styphnic acid, trinitro-orcin, triamido-resorcin, amido-diimido-resorcin, trioxyquinon, triacetyl-oxyquinon, tribenzoyl-trioxyquinon, trioxytoluquinon, and various other compounds closely connected with the above.

Synthesis of Phenyl-naphthalin.—Watson Smith.—The author has somewhat modified his process, described in *Berichte* (xii., p. 1396), using naphthalin in excess, and has thus obtained phenyl-naphthalin in larger quantities. He gives the formula of the pure compound as $C_{16}H_{12}$. Its vapour-density as experimentally determined is 7·10, calculation giving 7·05. The corrected melting-point is 95° to 96°.

On Cyanallyl and the Products of its Saponification.—A. Pinner.—The author contends that in the formation of cyanallyl no transposition of the allyl-radicle ensues. On its saponification by hydrochloric and by potassa lye the respective products are β-chlorbutyric acid and β-oxybutyric acid, both of which on further treatment with potassa are transformed into ordinary crotonic acid.

Preparation of Acetic-ester.—A. P. N. Franchimont.—The author finds that all the hydrates of carbon yield perfectly pure acetyl-derivatives if heated with 4 parts of acetic anhydride and a small fragment of fused zinc chloride.

A New Method of Preparing Hydrobromic and Hydriodic Acids.—G. Bruylants.—The author introduces into a tubulated retort, containing 500 c.c. and fitted with a reflux-condenser, about 60 grms. of the essential oil of copaiba. At the other end of the condenser is a bent glass tube which effects a connection between the retort and a drying-tower for gases, the lower end of which contains a light asbestos plug, whilst an escape-tube opens into its upper end. The oil is slightly heated, 20 grms. of iodine are gradually dissolved, and the temperature is raised. In a few moments there begins a copious and regular discharge of gas. When it abates the retort is allowed to cool a little, and a fresh dose of iodine is introduced. As the reaction is now less energetic, the iodine can be introduced in larger portions. Heat is again applied, and the operation is continued till 150 grms. of iodine have been consumed, which should yield 145 to 150 grms. of hydriodic acid. In the preparation of hydrobromic acid the same process is followed, but the gas should be allowed to pass through two or three drying-towers. It is also necessary to place the bromine in a dropping-funnel, and allow about 20 grms. to enter drop by drop: 150 grms. of bromine and 60 grms. of oil yielded 142 grms. of hydrobromic acid.

Thermo-chemical Researches on the Oxides and Acids of Nitrogen.—Julius Thomsen.—The author gives tables showing the heat liberated or absorbed in the formation of the oxygen compounds of nitrogen, of the anhydrous nitrates, of the nitrates of the formula $RO_2N_2O_4$, and of their solution-heat. He points out the serious discrepancies between his own results and those of M. Berthelot (*i.e.*, N_2O_5.Aq. −14800 Berthelot, and +180 Thomsen), and subjects the methods of the French chemist to a sharp criticism as far as NO is concerned.

Action of Nitroso-dimethyl-anilin upon Phenols not containing the Methyl Group.—Raphael Meldola.—A preliminary communication. The author dissolves 1 mol. β-naphthol in glacial acetic acid at about 110°, and adds gradually to the solution 1 mol. nitroso-dimethyl-anilin hydrochloride, when the mixture takes a fine blue colour and a bronze lustre. The melt is washed with water, dissolved in alcohol, and the solution is mixed with hydrochloric acid. The hydrochlorate of the base forms in long, splendid crystals, which dissolve in water and

alcohol with a fine violet-blue colour. Corresponding compounds have also been prepared from resorcin and α-naphthol. The former yields a violet-blue, and the latter a red colour.

Volatility of Platinum in Chlorine Gas.—F. Seelheim.—The author, on heating platinum-foil to bright redness in a current of chlorine for twenty-four hours, found a number of small crystals of platinum deposited in the tube beyond the foil. Platinous chloride was heated in a small, narrow-necked porcelain flask, to bright redness. The chloride disappeared, and the sides and bottom of the flask were found covered with minute but well-defined crystals of platinum, proving that platinum is decidedly volatile in an atmosphere of chlorine. As the assumption of the dissociation of chlorine in the experiments of V. and C. Meyer is based upon the supposition that platinous chloride, on heating, yields an absolutely fixed residue, its sole basis is thus removed, and there is no occasion for the hypothetical explanations of Lieben (*Comptes Rendus*, lxxxix., No. 6). The increase of one-third in the volume of the chlorine may be explained by the equation $Pt_2Cl_4 = 2Cl_2 + Pt_2 = 6$ vols.

On a Sulphuretted Colouring-matter from Paraphenylen-diamin.—A. Koch.—The base of this colour has the composition $C_{24}H_{20}N_6S_2$. As hydrochlorate it dissolves in water with a fine violet colour. Reducing agents decolourise the solutions, but the colour is restored by the oxygen of the air or by feeble oxidising agents. Powerful oxidisers completely destroy the compound. The precipitate given by acids dissolves in an excess of the precipitant with a pure blue colour. Several of its salts are here described.

Colouring-matters produced by the Action of Oxidisers upon Di- and Tetra-para-phenylen-diamin.—C. Wurster.—The red colour from the di-compound may be isolated in combination with bromine, and proves tolerably permanent. It is still more readily obtained as a ferro-cyanide.

Tetra-brom-ethans.—R. Anschütz.—An attempt to show the identity of Bourgoin's tetra-brom-ethan with perbrom-ethylen.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 3, January 15, 1880.

The Tay Bridge catastrophe is described under the heading "Barbarism of Exaggerated Civilisation."

Cast-iron Magnets.—M. Carré.—The author patents a process for making good magnets of cast-iron.

Utilisation of Sewage.—M. Ladureau.—The author contends that the sewage of Lille cannot be used in irrigation on account of the nature of the soil of the district, and of the humid and rainy climate, which would render irrigation in most cases, not merely injurious, but positively hurtful. The sewage of Roubaix Tourcoing he treats with lime and clay.

Various papers on chemical subjects are taken from the *Berichte der Deutschen Chemischen Gesellschaft* and from the *Chemiker Zeitung*.

No. 4, January 22, 1880.

Unexplained Electric Experiment.—If a hollow, open, metallic cylinder, capable of rotation around its axis, is placed above a magnet of double length, in such a manner that one of its extremities may coincide with the centre of the magnet, and the other with one of the poles, and if a strong electric current is passed from one end of the cylinder to the other it assumes a movement of rotation whose speed is independent of the resistance of the metal of which the cylinder is formed and of its thickness. Longitudinal grooves and slopes on the surface of the cylinder do not hinder the rotation. There is here, therefore, a conversion of electro-motive into pondero-motive force. Weber is of opinion that the resistance of the metal to the passage of the current is the cause of this transmutation of energy, which, nevertheless, has been supposed independent of such resistance. He says that the first tendency is that of a rotatory movement of the current in the conductor, but as such movement is only possible by a passage of the electricity through the matter of the conductor, overcoming its resistance, the principle of the minimum of heat requires that the energy should be transported in an indefinitely short time to the conductor itself.

Electricity and Steel.—Signor Guidi proposes to convert iron into steel by electric action. To produce 2 tons daily the continuous action of an electro-dynamic machine of 120 horse-power is required.

Apparatus for the Industrial Analysis of Gases.—H. Orsat.—From the *Bul. de la Soc. d'Encouragement.*

MISCELLANEOUS.

Balmain's Luminous Paint.—*Engineering* says:—"The Lords of the Admirality have been making experiments with it in a darkened room at Whitehall, and have expressed themselves in favour of it for lighting up the compartments of ironclads, or for the powder magazines; and two compartments of H.M.S. *Comus* have been ordered to be painted with it. For life-belts and buoys, it will of course be an acquisition in rendering them visible by night. A lantern capable of enabling a person to read or work in the dark can be made by framing a few square feet of painted surface; and the Superintendent of the West India Docks has ordered lanterns for use in their dangerous spirit vaults. The virtues of these lanterns in explosive mines, petroleum stores, and cellars, are too obvious to be dwelt upon. Mr. Towers, who has just supplied the German Navy with his speed indicators, and is now engaged in adapting them also to several English war vessels, notably H.M.S. *Northampton*, has decided to have the dials of his apparatus illuminated in this way, so as to enable seamen on the darkest night to read the index. Mr. Hollingshead, the enterprising manager of the Gaiety Theatre, is in treaty to secure the sole right to apply the paint in the production of theatrical effects; and it is probable that the process will soon come into conspicuous use as a medium for advertisements.

MEETINGS FOR THE WEEK.

MONDAY, 16th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. "The Manufacture of India-rubber and Gutta-percha," by Thomas Bolas, F.C.S.
TUESDAY, 17th.—Royal Institution, 3. Prof. Schäfer, "Physiology of Muscle."
—— Zoological, 8.30.
—— Civil Engineers, 8.
—— Society of Arts, 8. Mr. Alexander William Mitchinson, on "The Principal Causes of Disease in Tropical Countries, Scientifically Considered."
WEDNESDAY, 18th.—Society of Arts, 8. Mr. W. P. Andrew, "The Euphrates Valley Railway."
—— Meteorological, 7.
THURSDAY, 19th.—Royal Institution, 3. Prof. Dewar, "Chemical Progress."
—— London Institution, 7.
—— Royal, 8.30.
—— Zoological, 4.
—— Chemical, 8.
FRIDAY, 20th.—Royal Institution, 8. Rev. H. R. Haweis "Old Violins," 9.
—— Geological, 1. (Anniversary.)
SATURDAY, 21st.—Royal Institution, 3. Prof. Pauer, "Joseph Haydn," (with Musical Illustrations.)

TO CORRESPONDENTS.

H. Wilson.—For luminous paint and articles painted with it, apply to Messrs. Ihlee and Horne, Aldermanbury.

THE JOURNAL OF SCIENCE

for February (Price 1s. 6d.), includes—

The London Water Supply.
On Water and Air. By Prof. Tyndall, D.C.L., LL.D., F.R.S. (Lecture II.) Illustrated.
Report on Hollway's Process for Reducing Metallic Sulphides without External Fuel. By W. Mattieu Williams, F.R.A.S (Illustrated.)

London: 3, Horse-Shoe Court, Ludgate Hill.

TO SULPHATE OR MURIATE OF AMMONIA MAKERS AND OTHERS.

The Combustion of Sulphuretted Hydrogen, and its manufacture into Oil of Vitriol.

This apparatus has been successfully working or a series of years at the Chemical Works, Frizinghall, nr. Bradford (Messrs. Hunt and Illingworth's), the perfecting of which was the result of an incalculable amount of study on the part of the proprietors.

It is necessary, for the thorough and efficient working of the Plant to adopt as well their improved Plant for making Sulphate or Muriate of Ammonia.

The undersigned are open to treat with any person wishful to adopt the process:—

The executors of the late Mr. Wm. Hunt, Messrs. HUNT and GORLE, at the Chemical Works Wednesbury, Staffordshire;
Or Mr. THOS. ILLINGWORTH, Ilkley, Yorkshire.

CORPORATION OF BIRMINGHAM.

GAS DEPARTMENT.

TENDERS FOR TAR.

The Gas Committee of the Corporation of Birmingham are prepared to receive Tenders for the Tar to be produced at their various Works for a period of one, three, or seven years, from the 30th of June next.

The quantities produced in 1879 were as follows:—

Saltley Works	.. ..	8500 tons.
Windsor Street Works	.. .. ..	5000 „
Adderley Street	„	2500 „
Swan Village	„	3000 „
Total	.. ..	19,000 tons.

The Committee will receive Tenders either at a fixed price per ton, or at a price to be calculated on a sliding scale, varying with the selling price of products.

The Corporation are prepared to let on lease a portion of their surplus land on which Tar Works could be erected.

Forms of tender may be obtained on application to me.

EDWIN SMITH,
Old Square Birmingham. Secretary

Producers of Alum Cake are requested to furnish us with their prices per cwt. and per ton.—Sutton and Paillips, Works, Stowmarket, Suffolk.

FOR SALE, a small lot (fully 1 ton) Chloride Magnesium.—Address, Jas. W. Gardner, 137, Barnsbury Road, Islington, London, N.

RETORT CARBON.

About 40 Tons on Sale,—Further particulars on application to Mr. Geo. B. Jackson, Gas Dept., Town Hall, Manchester.

Stearine Candle Maker Wanted for Abroad. One who understands thoroughly the different processes, and is competent to refine and purify glycerine upon the most approved system.—Apply to George Bennet and Co., Oil and Chemical Engineers, Glasgow.

POLYTECHNIC.—MARY QUEEN OF SCOTS.—The principal events in the life of the beautiful and unfortunate Mary Stuart, illustrated by Tableaux Vivants. The descriptive poem recited by Miss Alice Burnelle. The appropriate vocal music by a Choir of Glee Singers, under the direction of Mr. Stedman, daily at 3.30 and 8.30; Edison's Loud Speaking Telephone, &c., by Mr. Daniel, 10.30; the Zulu War and the Heliograph, by Mr. King, 11; London as it Was and Is, 11.30 and 8; the Electric Light, 12; Instrumental Concert by the Paggi Family, 2.30 and 7.30; Popular Optical Lecture, 3, by Mr. King: Phenomena of Light and the Ghost; by Mr. King, 6.30. Open 10 till 1, 2 till 5, and 6 till 10. Admission 1s. Reserved Seats, 2s., 1s., and 6d.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S, Ardwick Chemical Works Manchester.

ESTABLISHED 1798.

ROBERT DAGLISH & CO.,

ENGINEERS, BOILER AND BRIDGE MAKERS, MILLWRIGHTS,

BRASS AND IRON FOUNDERS.

Manufacturers of every description of Condensing, or High-pressure Blowing, Pumping, Rolling, Winding, and Patent Steam-engines, of any required power, for Irrigating, Draining, Mining, Rolling Mills, or Water Works purposes, and Manufacturers of every description of Chemical, Colliery, Copper Ore, Gold Mining, Glass, and Rock-salt Machinery.

Black-ash Revolving Furnaces of the Most Approved Type.
Bessemer Steel-Rail Plant.
Compressing-Engines for Collieries, Iron Works, and Weldon's Patent Bleaching-Powder Process.
Caustic, Chlorate, Decomposing, Nitre, Nitro-Glycerine, Iodine Potash, Sulphur, Acid, and Oxalic Pans.
Gas Producers Patent for Heating and other Purposes.
Pyrites Burners for Irish, Norwegian, and Spanish Ores of Improved Construction.
Patent Rousing Machinery for Brewers.
Retorts, Acid, Gas, Iodine, Nitric, Nitre, Nitro-Glycerine, and Vitriol Refining.
Steam Superheaters improved for Oil, Tar, and Resin Refining.
Steam Sulphur Melter.
Stills for Oil, Resin, and Tar.
Wheels, Bevel, Mitre, and Spur Moulded on the Shortest Notice by Patent Machinery.
Makers of Mactear's Patent Carbonating Furnace, Jones and Walsh's Patent Sulphate of Soda Furnace, Parnell and Simpson's Patent Causticiser, and Kynaston's Patent Alum Plant.

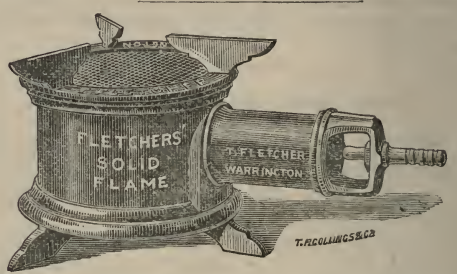
Lists sent on Application.

Photographs, Plans, and other information supplied on receipt of Order.

ST. HELEN'S ENGINE, BOILER, AND BRIDGE WORKS AND FOUNDRY,

LANCASHIRE.

Fletcher's | Solid Flame | Burner.
(TRADE MARK)



Will with equal ease boil an egg in a small tin saucepan or melt half a hundredweight of lead in an iron pot. It will boil half a gallon of water in a flat copper kettle in five minutes, and will melt six pounds of lead or solder in an iron ladle in seven minutes. Height, 5 inches. Price, in galvanised iron, 4s. 6d. Complete list of Gas Furnaces for all purposes; hot and cold blast blowpipes; automatic, foot, and hand blowers; instantaneous water heaters, &c.. on application.

THOS. FLETCHER,

MUSEUM STREET, WARRINGTON

BISULPHIDE OF CARBON,

CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,

161, 162 163, PALMERSTON BUILDINGS, LONDON, E.C

SILICATE OF SODA, Solid and in Solutions of Various Degrees of Concentration: the finest quality obtainable, and especially adapted for the use of Soap Makers and other Consumers.—JOSEPH CROSFIELD and SONS, Soap Makers, &c., Warrington.

London Agent—H. B. CLARKE, 37, Great Tower Street, E.C

THE CHEMICAL NEWS.

Vol. XLI. No. 1056.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 72.)

The two missing elements in the fifth series (third and fourth groups) should have very distinct properties. They will be found in this series between Zn = 65 and As = 75, and being atomanalogous with aluminium and silicium, they will be called, the one *eka-aluminium*, and the other *eka-silicium*. As they belong to an odd series they will give volatile metallo-organic compounds, as well as volatile anhydrous chlorides, but they will have much more acid properties than their analogues Eb and Ti of the fourth series have. The metals should be very easily obtained by reduction with carbon or sodium. Their sulphides will be insoluble in water, and Ea_2S_3 will be precipitated by sulphide of ammonium, whilst EsS_2 will be apparently soluble in it. The atomic weight of eka-aluminium will be about 68, and that of eka-silicium about 72. Their densities will be about 6·0 for Ea, and 5·5 for Es, and their volumes will be about 11·5 for Ea, and 13 for Es, as the volume of Zn = 9, of As = 14, and of Se = 18. We obtain the same numbers when comparing (for Ea) the volumes of Al, In, and Tl; and (for Es) the volumes of Si, Sn, and Pb, because the first-mentioned elements are the atomic analogues of Ea, and the last those of Es. The volume of Si = 11, that of Sn = 16; accordingly that of Es = 13. In short, in the case now before us, we can find atomanalogues on all sides, and therefore it is possible to determine the properties more exactly than we could when examining Eb. These determinations result from the following atomanalogues: — Eka-aluminium, giving the oxide Ea_2O_3, occupies the place between Ea and As on the one hand, and Al and In on the other hand; eka-silicium, giving the oxide EsO_2, occupies the place between Ea and As on the one hand, and Si and Sn on the other hand. All these circumstances indicating a necessary analogy between Ea and Eb, as well as between Es and Ti, I am going only to submit Es to a comparative examination with Ti, so as to get a clear idea of the properties of these elements.

Eka-silicium will be extracted from EsO_2, or from EsK_2F_6, by the action of sodium; it will only decompose steam with great difficulty; it will hardly react on the acids, but will easily attack the alkalies. It will be a dirty grey metal, difficulty fusible, and will be turned by calcination into a finely-divided oxide, EsO_2, which also will be very difficult to fuse. The density of the oxide will be about 4·7,* corresponding to the volume, which, judging approximatively, according to the volumes of SiO_2 and SnO_2, will be about 22. This oxide in its looks, and apparently in its crystalline forms, in its properties, and in its reactions, will resemble TiO_2. The acid properties being feeble, although decided, as much in TiO_2 as in SnO_2, Es will have the same character, and will form a more decided acid than TiO_2. In this, as in simllar cases, we have recourse to proportions. According to the proportion—

Es : Ti = Zn : Ca = As : V,

the basic properties should be more feebly shown in EsO_2 than in TiO_2, but more strongly than in SiO_2. We can therefore safely predict a hydrate of EsO_2, soluble in acids, although the solution will probably decompose easily, leaving an insoluble metahydrate. We can see that these properties correspond to those of TiO_2. However, EsO_2 will be more easily separated from its acid solutions than TiO_2 is, but it will be more difficult to separate from its alkaline solutions. It is certain that EsO_2 will furnish a series of double fluorides, K_2EsF_6, isomorphous with the corresponding salts of Si, Ti, Zr, and Sn; the double salt of potassium will be more soluble than the corresponding salt of Si. Like TiF_4, ZrF_4, and SnF_4, the fluoride of eka-silicium will not be gaseous, which will apparently result from polymeric changes, the same as for the other fluorides mentioned. The composition and size of the molecule of fluoride of silicium is SiF_4, that of fluoride of titanium is apparently Ti_2F_8, chloride of eka-silicium, $EsCl_4$, unlike the fluoride, will be a volatile liquid, boiling at 100° (or perhaps a little lower), as $SiCl_4$ boils at 57°, and $SnCl_4$ at 150°. We shall find by means of this property, a practical method of separating eka-silicium from Ti, seeing that $TiCl_4$ boils at 136°. In its other properties $EsCl_4$ will coincide with $TiCl_4$. The density of $EsCl_4$ will be about 1·9 (at 0°), its volume will be about 113, as the volume of $SiCl_4 = 112$, and that of $SnCl_4 = 115$ (the density of $FCl_4 = 1·76$).

A marked difference between Es and Ti will consist in this, that Es, like Si and Sn, will be able to form metallo-organic compounds, such as $EsAe_4$, whilst Ti, belonging to an odd series in the system, will not form compounds of this nature. Judging from the properties of Sn and Si, $EsAe_4$ will boil at 160°, and its density will be about 0·96. This last-mentioned property will serve to separate Es from Ti, Zr, and Nb, if they happen to be present.

In my opinion it is in those numerous but insufficiently studied minerals, minerals with complex compositions, and containing Ti, Zr, and Nb, that we should look for Es, as well as for several other unknown elements. The great resemblance between the properties of Ti and Es allows us even to suppose that Es has escaped observation, although it was present in titaniferous minerals; the difference of the results, relative to the equivalent of titanium, leads to this supposition. To determine the atomic weight of Ti, Rose,* Pierre,† and Demoly‡ decomposed $TiCl_4$ by water, and having weighed the Cl present, admitting Ag = 108 and Cl = 35·5, they obtained the following results:—

Rose,	from 48·08 to 48·48;	average,	48·26
Pierre,	,, 50·34 ,, 49·55;	,,	50·0
Demoly	,, 57·3 ,, 55·9;	,,	56·8

It is difficult to attribute such a want of concordance to differences and errors in the processes of research of the different investigators; we should rather admit that the $TiCl_4$ contained foreign unsuspected matter. We should also believe, because of the periodic law, that the numbers found by Pierre and Demoly are too high; for the atomic weight of Ti should be a little higher than Ca = 40, but a little lower than V = 51 and Cr = 52. The number therefore found by Rose seems to be the correct one, whilst the chloride of titanium used by the other workers must have contained impurities which raised the atomic weight. $EsCl_4$ being a chloride analogous to $TiCl_4$, and as Es should have a higher atomic weight than Ti (viz., 72), it seems to me that Es should be looked for in $TiCl_4$, which has been prepared from rutile coming from various localities. However, a trial that I made did not show me any body in $TiCl_4$ which would boil below 135°.

I would mention that on several occasions new elements have been supposed to have been discovered in the compounds of Ti, Nb, and Zr, and some researches lead us to think that Es might have been present in some cases. We know that Hermann believed that he had discovered

* Kokscharoff has described, under the name of *ilmenorutile*, a body analogous to rutile, but which has the density 4·8, whilst ordinary rutile has the density 4·2; 4·8 corresponds to the density of oxide of eka-silicium.

* *Poggendorf's Annalen*, vol. xv., p. 145.

† *Annales de Chimie et de Physique*, 3rd series, vol. xx., p. 257.

‡ *Ibid.*, vol. xxii., p. 213.

ilmenium, although Marignac* showed later on that the colombites, which had been suspected of containing ilmenic acid, in reality only contained a mixture of titanic, niobic, and tantalic acids. To confirm Marignac's assertion—which was that Hermann's ilmenic acid was only a mixture of titanic and niobic acids—we can say that the equivalent of ilmenium found by Hermann occupies the place between the equivalents of—

$$\mathrm{Ti}\left(12=\frac{48}{4}\right) \text{ and of } \mathrm{Nb}\left(19=\frac{94}{5}\right).$$

But Marignac himself has not succeeded in finding an exact method for the separation of titanic from niobic acid: he himself admits that his process (based on the difference of solubility of the double fluorides of potassium) is insufficiently complete. We have, therefore, a perfect right to be sceptical of the exactness of his results, however reasonable they may seem, and I further hold that a repetition of his work would not be superfluous, more especially as Ti and Nb can be separated in the form of chlorides, compounds whose boiling-points show considerable differences.†

The examples that I have given show sufficiently in what manner we can, by means of the periodic law, foresee the properties of unknown elements; therefore I will not pursue the subject of describing the elements which are wanting in the system. The discoveries which would offer the most interest would be those of the following elements:—Eka-cæsium, Ec=175: dui-cæsium, Dc=220; eka-niobium, En=146; eka-tantalum, Et=235; and the analogues of manganese, for example:—Eka-manganese, Em=100; and tri-manganese, Tm=190.‡ For it is difficult to consider the absence of the whole of a series (the ninth), and nearly all a large period (from Ce=140) as an accidental circumstance: the reason of this gap is very probably caused by the nature of elements.

When we reflect on the problems which form the subject of this memoir another question presents itself:—Is the number of elements limited or unlimited? If we consider that the system of the known elements is limited, and, so to speak, closed; that the aërolites, the sun, and the stars contain only the same elements as the earth; that the acid properties disappear little by little as the atomic weight increases; and that the greater number of the elements with high atomic weights constitute the heavy and difficultly oxidised metals; if, I say, we consider all this to be case, we must admit that the number of accessible elements is very small; and we may presume that if several more heavy metals are found in the interior of the earth, their number and their quantity will be very limited.

A New Voltaic Condenser.—M. d'Arsonval.—The author, seeing the energetic, though brief, effects produced by secondary batteries, and in particular by that of M. Gaston Planté, sought for a condenser capable of storing up a much larger quantity of electricity. He forms a couple of a plate of zinc and a plate of coke, surrounded by lead in a very fine state of granulation immersed in a concentrated solution of sulphate of zinc. He also substitutes for the zinc a layer of mercury.—*Comptes Rendus*, tome xc., No. 4.

* *Archives des Sciences Naturelles*, January, 1866, and August, 1867.

† I would again drawn attention to the fact that, judging from its atomic analogy with As and Sn, Es might be met with in the minerals which contain these last elements. Wœhler mentions (*Mineralanalyse*, par. 96) that when tungsten is treated with *aqua regia* and ammonia, an insoluble residue of niobic (up to 2 per cent) and silicic acids is left. The further study of niobic acid would be very interesting, as Wœhler's work on that subject was published at a time when this mineral was very little known.

‡ Perhaps Ru and Os occupy these places, if their highest oxides are like R_2O_7 and not RO_4. However, if such were the case, the true analogues of Fe would be missing. A comparative study of OsO_4 and Mn_2O_7 is very desirable.

ON A NEW METHOD OF SPECTRUM OBSERVATION.*

By J. N. LOCKYER, F.R.S.

In anticipation of my report on the Methods of Mapping Spectra, which I have been requested to prepare for the Solar Committee, I beg to present to them the following account of some recent work which has been suggested during the preparation of that report. In the *Phil. Trans.* for 1873† I gave an historical account, showing how, when a light source, such as a spark or an electric arc, is made to throw its image on the slit of a spectroscope, the lines had been seen of different lengths; and I also showed, by means of photographs, how very definite these phenomena were. It was afterwards demonstrated that chemical combination or mechanical mixture gradually reduced the spectrum by subtracting the shortest lines and leaving only the long ones.

On the hypothesis that the elements were truly elementary, the explanation generally given and accepted was that the short lines were produced by a more complex vibration imparted to the "atom" in the region of greatest electrical excitement, and that these vibrations were obliterated or prevented from arising by cooling or admixture with dissimilar atoms.

Subsequent work, however, has shown‡ that of these short lines *some* are common to two or more spectra. These lines I have called basic. Among the short lines, then, we have some which are basic and some which are not.

The different behaviour of these basic lines seemed, therefore, to suggest that not all of the short lines of spectra were, in reality, true products of high temperature.

That some would be thus produced, and would therefore be common to two or more spectra, we could understand by appealing to Newton's rule, "Causas rerum naturalium non plures admitti debere quam quæ et veræ sint et earum phænomenis explicandis sufficiant," and imagining a higher dissociation. It became, however, necessary to see if the others would also be accounted for.

I have already given to the Royal Society a preliminary account of the extraordinary, because unexpected, phenomena and changes observed in the spectra of vapours of the elementary bodies when volatilised at different temperatures in vacuum tubes. Many of the lines thus seen alone, and of surpassing brilliancy, are those seen as short and faint in ordinary methods of observation, and the circumstances under which they are seen suggest, if we again appeal to the above rule, that many of them are produced by complex molecules.

In this case the appeal lies to the phenomena produced when organic bodies are distilled at varying temperatures, the simplest bodies in homologous series are those volatilised at the lowest temperatures; so that on subjecting a mixture of two or more liquids to distillation, at the beginning a large proportion of the more volatile body comes over, and so on.

At any particular heat-level, then, some of the short lines may be due to the vibrations of molecular groupings produced with difficulty with the temperature employed, while others represent the fading out of the vibrations of other molecular groupings produced on the first application of the heat.

In the line of reasoning which I advanced a year ago§ both these results are anticipated, and are easily explained. Slightly varying Fig. 2 of that paper, we may imagine furnace A to represent the temperature of the jar spark, B that of the Bunsen burner, and C a temperature lower than that of the Bunsen burner.

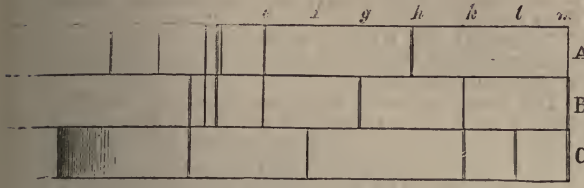
* A Paper communicated to the Royal Society at the request of the Committee on Solar Physics.

† *Phil. Trans.*, 1873, p. 254.

‡ *Proc. Roy. Soc.*, vol. xxviii., p. 159.

§ *Proc. Roy. Soc.*, vol. xxviii., p. 162.

Then in the light of the paper the lines *b* and *c* would be truly produced by the action of the highest temperature, *c* would be short and might be basic, while of the lines *h* and *m*, *m* would be short and could not be basic, because it is a remnant of the spectrum of a lower temperature.



A. Highest temperature. C. Lowest temperature.

To make this reasoning valid we must show then that the spark, or better still the arc, provides us with a summation of the spectra of various molecular groupings into which *the solid metal which we use as poles* is successively broken up by the action of temperature.

We are not limited to solid metals; we may use their salts. In this case it is shown in the paper before referred to* that in very many cases the spectrum is one much less rich in lines.

I have therefore attempted to gain new evidence in the required direction by adopting a method of work with a spark and a Bunsen flame, which Colonel Donnelly suggested I should use with a spark and an electric arc. This consists in volatilising those substances which give us flame spectra in a Bunsen flame and passing a strong spark through the flame, first during the process of volatilisation, and then after the temperature of the flame has produced all the simplification it is capable of producing.

The results have been very striking: the puzzles which a comparison of flame spectra and the Fraunhofer lines has set us find, I think, a solution, while the genesis of spectra is made much more clear.†

To take an instance, the flame spectrum of sodium gives us, as its brightest, a yellow line, which is also of marked importance in the solar spectrum. The flame spectra of lithium and potassium give us, as their brightest, lines in the red which have not any representatives among the Fraunhofer lines, although other lines seen with higher temperatures are present.

Whence arises this marked difference of behaviour? From the similarity of the flame spectrum to that of the sun in one case, and from the dissimilarity in the other, we may imagine that in the former case—that of sodium—we are dealing with a body easily broken up, while lithium and potassium are more resistant; in other words, in the case of sodium, and dealing only with lines recognised generally as sodium lines, the flame has done the work of dissociation as completely as the sun itself. Now it is easy to test this point, for if this be so then (1) the chief lines and flutings of sodium should be seen in the flame itself, and (2) the spark should pass through the vapour after complete volatilisation has been effected without any visible effect.

Observation and experiment have largely confirmed these predictions. Using two prisms of 60° and a high-power eyepiece to enfeeble the continuous spectrum *of the densest vapour produced at a high temperature*, the green lines, the flutings recorded by Roscoe and Schuster, and another coarser system of flutings, so far as I know not yet described, are beautifully seen. I say largely, and not completely, because the double red line and the lines in the blue have not yet been seen in the flame, either with one, two, or four prisms of 60°, though the lines are seen *during volatilisation* if a spark be passed through the flame. Subsequent inquiry may perhaps show that this is due to the sharp boundary of the heated region, and to the fact that they represent the vibrations of molecular groupings more complex than those which give us the yellow and green lines. The visibility of the green lines, which are short in the flame, taken in connexion with the fact that they have been seen alone in a vacuum tube, is enough for my present purpose.

With regard to the second point, the passage from the heat-horizon of the flame to that of the spark, after volatilisation is complete, produces no visible effect, indicating that in all probability the effects heretofore ascribed to *quantity* have been due to the presence of the molecular groupings of greater complexity. The *more there is to dissociate, the more time is required to run through the series, and the better the first stages are seen.*

Let us now turn to lithium.

Seeing that the red line is absent while the violet lithium line is strong among the Fraunhofer lines, we may imagine that the flame has not done the work of dissociation in the case of lithium so completely as the sun does it, so that (1) the other lines of lithium should not be visible, even with the new precautions, in the flame spectrum, and (2) a passage from the heat-level of the flame to that of the spark after volatilisation should produce the other lines which we know to exist in the spectrum of the metal in the orange, blue, and violet.

Experiment and observation have also confirmed this result so far as the yellow and blue lines go; that in the violet is difficult of observation.*

We next come to potassium.

The potassium lines usually recorded as not seen in a flame, but which are observed with a spark, are not very brilliant; nor are they strong among the Fraunhofer lines. Seeing therefore that a high temperature does not greatly develop them, we may expect to find them in the flame. They are almost all there when they are looked for with proper precautions, but those in all probability present in the sun are brightened on passing the spark, showing apparently that the flame volatilises with some difficulty the molecule which gives the line in the red.

The flame spectrum of magnesium perhaps presents us best with the beautiful effects produced by the passage from the lower to the higher heat-level, and shows the important bearing on solar physics of the results obtained by this new method of work.

In the flame the two least refrangible of the components of *b* are seen associated with a line less refrangible, so as to form a triplet. A series of flutings and a line in the blue are also seen.

On passing the spark, all these but the two components of *b* are abolished. We get the wide triplet replaced by a narrow one of the same form, the two lines of *b* being common to both (see Fig. 2).

When the line in the blue disappears on passing the spark two new lines are seen. The spark lines are in the sun, but the less refrangible member of the wide triplet and the blue line seen in the flame are absent.

The following are the details of some of the experiments which have been made on the above points:—

* *Phil. Trans.*, 1873, p. 258.

† I allude more especially to the production of triplets, their change into quartets, and in all probability into flutings, to the vanishing of flutings into lines, by increasing the rate of dissociation.

* The way in which the lines in the flame are unaffected by the spark strikingly reminds me of the following remarks of Angstrom and Thalén:—"The Fraunhofer lines can in general be divided, according to their appearance, into two classes; the one sharply defined and tolerably deep black, the other by no means so decidedly marked either as to form or colour. These two different kinds of lines are, as regards their appearance, very happily characterised by the opinion expressed on a former occasion, that the former, especially when the illumination is feeble, look as if they were situated considerably in front of the faint ground on which the latter seem to lie. The most prominent lines of the former class almost all proceed from iron: and those which remain, after the iron-lines are abstracted, belong to the other metals – calcium, manganese, chromium, &c."—("Angstrom and Thalén on the Fraunhofer Lines, together with a Diagram of the Violet Part of the Solar Spectrum." Upsala, 1866, p. 5.)

Experiment No. I.—Two pieces of platinum wire were supported in a Bunsen flame at a distance from one another of about 3 millims. They were then connected with a Holtz machine, in order that the spark might be passed inside the flame.

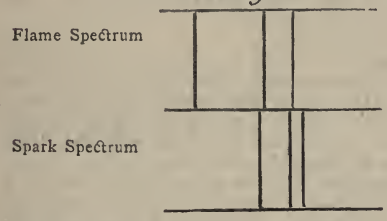
An image of the platinums was then thrown on the slit of the spectroscope by means of a lens. The spectroscope used had two dense flint prisms of 60°.

A piece of charcoal soaked in solution of sodic chloride was put into the base of the flame first, and then just below the platinum, and the spectrum observed; it consisted simply of the yellow line D. The spark was passed and the spectrum again observed; it now consisted of D *plus* the lines of hydrogen and some air lines, the red and green Na lines and the green flutings being still absent.

Experiment No. II.—Same arrangements, except that a large induction coil was substituted for the Holtz machine. The same results were obtained with the sodic chloride.

Experiment No. III.—Metallic sodium was next tried. It was found that when the metal was put into the flame just below the platinums the green line and the flutings were seen without the spark, that is, at the ordinary temperature of the flame. On introducing the sodium into the lower part of the flame, the green double (λ 5687·2 and 5681·4) and the flutings were not seen, either with or without the spark.

Fig. 2.



Experiment No. IV.—Same arrangements as No II., with metallic sodium, and with a small blowpipe instead of Bunsen.

In this experiment the flame spectrum showed, besides the yellow line (D), the green double (λ 5687·2 and 5681·4), and also the flutings in the green, those in the red being absent. As soon as the spark was passed, the green double (λ 5687·2 and 5681·4) became brighter, while the flutings vanished.

In these observations the sodium was put into the flame *just below the platinums*. When put into the bottom of the flame the D line was seen alone.

Experiment No. V.—A glass tube ½ inch in diameter was prepared, about 6 inches in length, having two platinums sealed into it at a distance of 4 inches from each other. A bulb was blown at each end, so that the spectrum might be examined with the tube end-on. A piece of sodium was put into the tube, and the latter exhausted with a Sprengel pump. An Argand burner was placed at one end of the tube in order that the absorption of the vapour, as well as its radiation, might be observed. The metal was then very gradually heated by a Bunsen flame.

After the heating had gone on for about twenty minutes the absorption line of D appeared; this gradually increased in intensity.

On passing the spark along the tube, the bright lines of sodium appeared, the green double (λ 5687·2 and 5681·4), being distinguishable after D had been seen for a little time alone.

The temperature was now increased and the absorption spectrum again examined. The flutings in the green gradually made their appearance, D increasing in intensity, the green line being invisible. Afterwards the flutings in the red came in.

On passing the spark the absorption spectrum, consisting of the red and green flutings, disappeared instantaneously, and the green double was seen very bright; after the passage of the spark D dark was much increased in breadth.

The quantity of hydrogen given off during the change prevented the passage of the spark, and the observations had to be discontinued. As soon as some of this had been pumped out the same observations were repeated with the same results.

Experiment No. VI.—An experiment was made with lithic chloride in Bunsen flame, with the same arrangement as in Experiment No. I.

The flame spectrum with the dispersion employed showed no Li line except the red one (λ 6705·2). On passing the spark from the Holtz machine, the yellow line (λ 6102·0) and the blue line (λ 4602·7) appeared as bright as the red line. The same results were obtained on repeating the experiment with the large induction coil.

Experiment No. VII.—Potassic nitrate was tried by the method previously described in Experiment No. I.

The flame spectrum consisted as usual of the red lines (λ 7697 and 7663) and the blue line (λ 4045), very faint.

The effect of the spark was to bring out the yellow lines (λ about 5800), those in the green (λ about 5340), and the red double (λ 6946 and 6913) out of the flutings visible in the red, the double at 7697 and 7663 not being affected. The experiment was repeated with the induction coil, and the same observations made, with the additional one that the spark also slightly intensified the blue line.

Experiment No. VIII.—On repeating the experiment with metallic potassium the same phenomena were more markedly observed, the lines about λ 5800, and other lines more refrangible, were visible as very faint objects in the flame; they were much strengthened, however, by the passage of the spark.

Experiment No. IX.—Some potassium was volatilised by the spark in front of the slit of the sun-spectroscope and comparison of the positions of the lines with the Fraunhofer lines made. It is believed that λ 5829·0, 5802·0, 5782·5 are all reversed in the solar spectrum. The less refrangible member of the red double (λ 6946) was next compared, and was undoubtedly absent from the sun. These observations, however, are rendered extremely difficult on account of the fluted appearance of the yellow lines, and must be repeated with a stronger sun and the electric arc. The spectroscope employed had three prisms, one of 60° and two of 45°.

Experiment No. X.—The flame spectrum of magnesium was examined; a green triplet was observed, which was at first sight taken for *b*. Measurements, of the lines, however, showed that the less refrangible member was less refrangible than *b*, and had a wave-length 5209·8, and that the other two members were b^1 and b^2 respectively. A fresh charge of magnesium was put into the flame and the spark passed; the original triplet was now no longer visible, the line at 5209·8 having vanished, but b^4 was now seen forming with b^1 and b^2 a triplet of similar form on a smaller scale.

According to Thalén, there are three blue lines of magnesium at wave-length 4481·0. 4586·5, and 4703 5. These lines were looked for in the flame with and without the spark. Without the spark only one line was visible in this region; its position was found by comparison with the solar spectrum to be at wave-length 4570·3, and coincident with no Fraunhofer line. The passage of the spark abolished this line, at the same time bringing in the two lines given by Thalén at wave-length 4481·0 and 4703·5, both of which are reversed in the solar spectrum.

No line was seen at Thalén's wave-length 4586·5, the nearest approach to which was the line seen at the temperature of the Bunsen flame at wave-length 4570·3, a difference of more than sixteen divisions of the scale.

I am now preparing maps showing the phenomena observed at various heat-levels. I think it is not too much to hope that a careful study of such maps, showing the results already obtained, or to be obtained, at varying temperatures, controlled by observation of the condition

under which such changes are brought about, will, if we accept the idea that various *dissociations* of the molecules present in the solid are brought about by different stages of heat, and then reverse the process, enable us to determine the mode of evolution by which the molecules vibrating in the atmospheres of the hottest stars *associate* into those of which the solid metal is composed. I put this suggestion forward with the greater confidence, because I see that help can be got from various converging lines of work. To some of these I may briefly allude here :—

1. We have the lines present in the solar spectrum, and absent from it.

Example.—The red potassium line present in the flame is absent from the sun; some of the other lines are present.

2. We have the varying thicknesses of the lines of any one element in the sun to compare with the thicknesses produced at different temperatures in the laboratory.

Example.—The various lines of magnesium, notably *b*, the most refrangible line given by Thalén, and the other blue line.

3. We have the remarkable behaviour of metals vapourised in a vacuum at the lowest temperatures.

Example.—Sodium gives us D, potassium gives us the triplet in the green-yellow; calcium gives us the line in the blue; thus separating those lines from all the others of those metals.

4. We have the remarkable behaviour of the same vapours under like circumstances, the temperature alone being changed; when this is increased lines visible under ordinary conditions are brought in, and are seen in different parts of the tube, so that each line in turn (and therefore, I presume, each molecule which produces it) is separated from those with which it is generally seen in company.

Example.—By increasing the temperature we get the green line of sodium without D, and some of the magnesium lines have been seen separated from the others.

5. We have the power of determining the lower states by means of absorption phenomena, and then of observing the radiation of the vapours produced by the passage of a feeble current of electricity.

Example.—The fluted spectrum of sodium described by Roscoe and Schuster is instantly abolished by this means, and a brightening of the green and a considerable thickening of the dark yellow line is seen.

6. May we consider the existence of these molecular states as forming a true basis for Dalton's law of multiple proportions? If so, then the metals in different chemical combinations will exist in different molecular groupings, and we shall be able by spectrum observations to determine the particular heat-level to which the molecular complexity of the solid metal induced by chemical affinity corresponds.

Examples.—None of the lines of magnesium special to the flame spectrum are visible in the spectrum of the chloride either when a flame or a spark is employed. The facts recorded in my papers, printed in the *Philosophical Transactions* some years ago, on the spectra of salts and mixtures, seem all explained in this way.

I think, then, that the method of mapping, to be complete, should not only show the metallic lines as produced at various temperatures compared with the Fraunhofer ones, but that for each metal investigations should be made and recorded for as many heat-levels as possible, and for various chemical groupings such as—

CrO	Fe_2Cl_6
CrO_3	$FeCl_2$
Cr_2O_3	Fe
Cr,	

to give examples, with a view of investigating the facts, to see whether we can trace a molecular evolution in each case.

Further, the "basic" lines recorded by Thalén will require special study with a view to determine whether their existence in different spectra can be explained or not on the supposition that they represent the vibrations of forms, which, at an early stage of the planet's history, entered into combination with other forms, differing in proximate origin, to produce different "elements.

PROCEEDINGS OF SOCIETIES.

SOCIETY OF ARTS.

Wednesday, February 11, 1880.

George Godwin, F.R.S., in the Chair.

"*A New Metallic Compound*," by Granville Cole, Ph.D. The paper which I am about to read this evening affords me the privilege of appearing for the first time before a meeting of the members of the Society of Arts, and I hope you will grant me your indulgence for any shortcomings which may attend this my first appearance as a public lecturer in England.

The subject of the paper is the discovery of a metallic compound, which I shall prove to you is new, and I shall endeavour further to set forth a few facts, attested by experiments, in respect of its nature. I am duly impressed with the very technical character of my subject, and the tendency there must be, in dealing with it, towards a certain dryness in my remarks. But, while I trust that many of the *data* will appeal with special interest to engineers and other practical men, I still hope to arrest your attention by showing you to how many artistic and industrial purposes this new metallic compound may be put. In the first place it will be right to give a brief account of the—

I.—*Discovery of the Metal.*

Nearly a year ago, Mr. J. Berger Spence discovered that the sulphides of the metals, combined with molten sulphur, formed a liquid. This liquid, on cooling, became a solid homogeneous mass, possessing great tenacity, and having a peculiar dark grey—almost black—colour. Nearly every metallic sulphide which is known, combines, as experiments have proved, with an excess of sulphur, and curiously enough, nearly all these combinations have the same properties. The combination, of which I have specimens here for inspection, consists of an ore of iron pyrites containing both lead and zinc sulphides.

II.—*Chemical Composition.*

Examining the metal from a chemical point of view, I may state, briefly, that it is a chemical compound belonging to that class known as thiates, or sulphur sulphides.

Dr. Hodgkinson, chemical demonstrator at the Science Schools, South Kensington, has kindly sent me the following facts. I cannot do better than quote his letter on the subject :—

"It appears to be the easiest thing in the world to obtain a homogeneous casting with it. Specific gravities of portion sent gave 3·3743 to 3·7036 (reduced to 0° C.).

"When finely powdered, it is acted upon slowly by concentrated HCl and NO_2HO in the cold; in large lumps, little or no action takes place. As yet I have not been able to determine the expansion equivalent accurately; it would appear, however, to be small. The fracture is not conchoidal, as might perhaps have been expected, but somewhat like that of cast-iron.

"I have not had time to try many 'utilisation experiments' on the substance, but I have no doubt it would be exceedingly useful in the laboratory, even, for instance, for making the air-tight connections between glass tubes by means of caoutchouc, and a water or mercury jacket, where rigidity is no disadvantage; the fusing-point is so convenient, about 340°, that it may be run into the outer

tube on to the caoutchouc, which it grips, on cooling, like a vice, and makes perfectly tight.

"I don't know what you may call the material, but should think, as it seems to be more than a mere mixture, 'ferric thiate' would not be a bad or inappropriate name."

III.—*Properties of the Metal.*

I propose, this evening, to illustrate, by experiments such as are possible at a lecture, some of the properties of the metal. I will begin by giving you a short summary of its peculiarities, and its advantages over those of other metals or metallic compounds.

1. It has a comparatively low melting-point, viz., 320° F., or rather more than 100 above the temperature of boiling water. Here, then, we have in its favour the small amount of fuel needful to supply the necessary heat for reducing the metal to a condition for use.

2. It expands on cooling, a property not shared by the majority of other metals or metallic compounds. I believe that type metal and bismuth are two exceptions. Later on, I think I shall convince you that, for an operation like the joining of gas and water pipes, this expanding property is one of great importance.

3. It claims to resist atmospheric or climatic influences, as compared with bronze and marble. I noticed only a few days ago how the statues in bronze, on the Holborn Viaduct, had been affected by our London fogs. And I have evidence to produce in the direction of showing the imperviousness of the metal to such degrading influences.

4. As compared with other metals or metallic compounds, its resistance to acids, used commercially, to alkalies, and to water, is certainly superior.

5. A smooth surface of this metal or metallic compound, now known commercially as Spence's metal, takes a very high polish. I will illustrate this to you by casting some of this molten metal on to a surface of glass.

IV.—*Its Uses to Art.*

It may, perhaps, be interesting to my hearers to learn the manner in which Mr. Spence first thought of utilising this metal for works of art. In order to obtain a perfectly smooth surface, he had been running molten metal on to a piece of glass as I have just done. But before doing so he had chanced to touch the glass, and had left the marks of the pores of the skin of his fingers upon it. On removing the metal, these marks were found to be reproduced, and so indelibly that they did not disappear on polishing the surface metal. This led Mr. Spence to try to cast the metal in a mould; and although at present no artistic work of high order has yet been reproduced, yet I venture to think that enough has been done to justify the expectation that, in a short time, standard works of both ancient and modern art may be successfully and usefully reproduced. Various colours, such as the green patina of bronze, the dark blue hue of steel, and the appearance of silver and gold, have already been obtained. Experiments are now in progress which give promise of enabling those who adopt this metallic compound for such uses to reproduce metallic works in their original colours.

I have here a casting that was made from a nickel-plate engraving; every line, however minute, has been reproduced in Spence's metal. Experiments are now being carried on to test the adaptability of the metal for printing and stereotyping purposes, but they are not complete, so I refrain from giving you any facts about them.

Besides this, experimental castings have been made of various medallions and busts; notably, this large bust of Her Majesty the Queen. The metal in this case has not subsequently been treated in any way beyond being polished with a cloth. The metal can be cast into almost any material used for moulds.

Mr. Spence has succeeded in obtaining casts from metal moulds, plaster moulds, and even from gelatine moulds. These last are probably the first metallic castings produced from gelatine moulds. Spence's metal being almost a non-conductor of heat, cools so rapidly in the gelatine mould that it yields a perfect impression before the form of the mould is destroyed, and if the gelatine be allowed to remain on the metal till cold, it re-models itself ready for the next casting. It is, therefore, hoped that an additional process has been secured, by which the most undercut objects may be reproduced successfully and easily.

The advantages which Spence's metal possesses over other materials used for artistic productions, may be summarised under three heads, viz.:—1. Cheapness. 2. Facility of working. 3. Resistance to climatic influences.

Cheapness.—As compared with lead, which is one of the cheapest of metals, it is one-third the weight; and, whereas the average cost of lead for the last ten years has been nearly £18 a ton, Spence's metal only costs £15. A ton of Spence's metal being three times the amount in bulk of that of a ton of lead, it is available for three times the amount of work. It may, therefore, be considered to be nearly a quarter of the price of lead, and, consequently, very considerably less than that of bronze.

Facility of Working.—Its melting-point being very low, it can be very easily prepared for pouring into a mould, and its property of expanding, when cooling, causes it to take such a perfect impression, that the cast requires very little chasing after. In respect of a gelatine mould, which can cover a considerable surface of work without joins, such as one has to make in plaster-piece moulding, the metal cast obtained from such a mould would require no chasing whatever.

Resistance to the Atmosphere.—With regard to its resistance to climatic influences, experiments have been conducted in this direction with complete success. A polished surface of the metal has been exposed for six months in all weathers, without showing the least change.

Mr. Wood, the Secretary of this Society, has had a medallion, which I sent him a month ago, exposed to all the recent fogs and frosts, on the outside of this building. You can judge and see for yourselves how well it has stood this test.

Not to confine myself to his test alone, I have here another medallion of this metal, which Mr. Wood tells me has been left for the same period in *aqua regia*, one of the strongest acids known. You see how little effect the acid has had on the surface of the metal. I believe that no work of art in any other substance would bear this test without suffering. I will here endeavour to show you the effect the same acid has on marble or bronze. I venture to think that if Spence's metal has resisted this acid for a month, it ought certainly to be able to resist the climate of London for a very much longer period. I therefore beg to submit that this metal, if skilled labour is brought to bear on it, ought to be of a great value for decorative purposes, both internal and external.

V.—*Industrial Uses.*

I will endeavour now to point out to you the uses to which this metal may be applied for industrial purposes. And I propose to divide these purposes under three heads:—1. Gas and water works. 2. Chemical works. 3. Miscellaneous.

Gas and Water Works.—As practice is better than theory, I will simply relate, as best I can, those experiments which have been tried at the South Metropolitan Gas Works. Experiments, under the direction of Mr. Livesey, were made some weeks back. Two pipes were joined by this metal in much less time than would have been taken had lead been employed. The pipes, after having been joined, were tested under pressure, but no leakage was found.

Method of Joining Pipes with Lead.—In order to show the especial advantages this metal has over lead, it will be as well here, if I endeavour to tell you how gas or water pipes are joined when lead is used. The pipes having been laid together, the joint is packed with yarn; clay is then laid round the exterior of the joint, and the molten

lead is run in. Unfortunately, lead possesses the property of contracting on cooling. The leaden joint has, therefore, to be "caulked," or, as it is called in the north, staved. This caulking, or staving, means wedging the lead into the joint, in order to obtain a perfectly tight join. This caulking naturally occupies considerable time, and necessitates excavation, in order to allow the men to work all round the pipes.

Excavation and caulking are both rendered unnecessary by the use of Spence's metal. The pipes have only to be laid together, and after the yarn has been forced into the joint and the clay placed, the liquid metal is run into the joint, the clay removed, and the joint is finished. The metal does not splash in running into the mould, thus avoiding a great source of waste of material, and danger to workmen.

Experiments were also tried to test the metal joints in the event of subsidence of the ground. Four lengths of nine feet piping, six inch diameter, were joined with the metal, and supported on treseles. After the metal had set, which it did in a few minutes, the centre supports were knocked away, leaving only the two end ones. The 36 feet length of piping sank 7 inches, without showing, even after pressure, a leakage.

These experiments were so satisfactory, that the South Metropolitan Company have adopted the metal, and are now laying their pipes with it. Mr. Livesey, the chief engineer, in writing on the subject to Mr. Spence, says:—"We have now only the test of time, and that, I think, we may take the risk of." Others of the London gas works, and a very large number of provincial gas works, are adopting it.

In the same way, it will be useful for water works. Mr. Hope, who undertook some experiments in Scotland, reports that at the Edinburgh Water Works two pipes were joined, and subjected to a pressure of 400 feet of water, which was as much as they could get on, without the joint showing any leakage. This is the greatest pressure which we have as yet been able to put it to; so what it will actually bear, I am not at present in a position to say.

From a sanitary point of view, as water has no action on the metal, it would be extremely valuable for cisterns, instead of iron or lead. Being almost a non-conductor of cold, pipes might be lined with it to prevent the water from freezing.

Uses to Chemical Works.—The metal being less acted upon by acids than other metals, it may also be of service to chemical manufacturers. I refer especially to sulphuric acid, which is the most extensively used of all acids in commerce. Lead has, up to the present, been used for sulphuric acid tanks. I have myself tested the metal with sulphuric acid, and its action is almost imperceptible. The one objection to the use of this metal in this case is its low fusing-point, but when acids have only to be used up to a certain temperature, say 200° F., I venture to predict a large field for its use.

VI.—*Miscellaneous Applications.*

Besides the uses I have thus briefly and, I am afraid, somewhat imperfectly set before you, there are many others to which the metal may be applied, for instance, joining iron to stone or wood, the tensile strain of the metal being from 650 lbs. to the square inch five minutes after setting. For joining railings to stone it would answer equally as well as lead, and cost very much less; also for coating the holds of ships. I have been told that an Act of Parliament has been passed by which builders are compelled, if the district surveyors desire, to cover the walls of houses after they are built two feet out of the ground, with some material to prevent the damp from rising. It seems to me that Spence's metal is peculiarly adapted for this purpose.

I will illustrate to you some of the other uses to which this metal may be put. For hermetically sealing bottles; for covering cloth; for covering parcels that are being sent out to hot climates, thus obviating the use of lined boxes; for preserving fruit, or other articles of consumption; and I may state that experiments on a large scale are still being carried on at Mr. Spence's works, Belvedere, Kent.

VII.—*Conclusion.*

I feel sure we have not yet come to the end of all the uses this Spence's metal may be put to, but I trust that I have shown you sufficient to induce you and others who may be interested in this discovery to make further investigations. If my paper is somewhat shorter than is usual, it is to some extent owing to my hesitation to make any statement which either Mr. Spence or I have not verified by actual experiment ourselves. I have already shown you a few of them, viz., casting on glass. casting an engraving, casting in metal moulds, casting in plaster moulds, casting in gelatine, resistance to atmospheric action, resistance to acids, and resistance to acids as compared to bronze or marble, and uses in gas and water works. In conclusion, I express a hope that I have established the proposition with which I started, and I trust you are satisfied that this Spence's metal is a discovery which has a prospect of much utility to the fine and industrial arts, and that I have been justified in bringing it before the attention of the members of the Society.

Discussion.

The Chairman said that Dr. Cole had certainly proved that there was in one way or other a very large field for the employment of this new metal. It was very curious to see how an invention first made with a particular object sometimes took afterwards an entirely different direction. This material was first brought forward as affording admirable reproductions of works of art, and now they were informed that it could be used to preserve fruit, and possibly meat, and so it might solve the difficulty of bringing over American and Australian meat. This reminded him of an admirable invention for wood-carving, which made no way at first, but when troubles overtook France, and prevented the exportation of wooden heels for ladies' shoes, all the machines in London were immediately set to work profitably. So with Mr. Ransome's patent stone: it did not seem to take until it was turned to making large grindstones, for which it was admirably adapted. The same thing might occur in this case. This metal was already in profitable use for joining gas- and water-pipes, where it possessed considerable advantages, not merely because lead required wedging in order to make a tight joint, but very often from the difficulty of getting at the under side of the joint, it was imperfectly accomplished; whereas this metal, from its fluidity, penetrated all round, and so made a good piece of work of it. It must not be too readily taken for granted that its power of resistance was proved; because, though it had been exposed for seven or eight months, that was really nothing in point of time: they had bronzes thousands of years old which were still perfect, though others, imperfectly made, such as some in that metropolis, which were not twenty years old, were already decaying. The last time he had looked at the paws of the noble lions in Trafalgar Square he noticed they were full of holes; and if some means were not devised for preventing further decay their ruin was certain. However, what they had already heard said a good deal for the durability of this metal. It was quite certain they needed a material for the reproduction of works of art which should be cheap, hard, and durable. Sulphur itself had considerable power of resisting atmospheric influence, and many other reasons might be suggested why this compound might be expected to be durable, and if so, it would be a great boon for artistic purposes; but there were many other directions in which it would be useful, as, for instance, the joining of iron railings to stone copings. Probably owing to galvanic action, lead, which was generally used, had a very prejudicial effect on the stone. After the popular outbreak in Hyde Park, which led to new railings being

put up, he noticed, within a year, that at every ten or twelve feet, where the iron bars were thicker than usual, the piece of stone had been driven forcibly out of the kerb, which entailed a large expense in the repairs. Lead poisoning was another thing which naturally occurred to one, and if this could be used as a coating for pipes, or for the material of pipes, if not too brittle, it would have the double advantage of preventing the decomposition of the lead and also the possibility of freezing.

The Secretary narrated the tests to which he had subjected the specimens sent him by Dr. Cole. When Dr. Cole first mentioned the compound to him he said it was not liable to be affected by acids, and he (Mr. Wood) then suggested that if a couple of specimens were sent to him he would himself test them, and relate the result to the meeting. One of these medallions he put on the roof of the Society's house about a month ago, and as they all knew, during the intervening period, they had had every possible description of bad weather. The time was not long, but if the material had been at all subject to atmospheric influences it could hardly have failed to show some signs; at any rate the glassy surface would have been somewhat dimmed, but nothing of the kind was apparent. The other medallion he put into a basin with nitric and hydrochloric acid, about the strongest mixture of acids known to chemists. The surface of this had certainly been affected, and probably there were no substances, except gutta-percha or earthenware, which would have escaped. An iron hook, by which the medallion was intended to be hung, dissolved entirely in a few days. Dr. Cole gave him a piece of the compound, with which he had experimented, and he found it exceedingly easy to work. You could take casts as easily as with wax. The only thing necessary was to get the right temperature. At anything under about 320° it was pasty, and if you went much beyond that temperature it became pasty again, but between 320° and 350° it was perfectly liquid, and could be poured into the very finest mould. He thought it rather a pity that a better name had not been devised for the material, as it was certainly not a metal.

Mr. Livesey said he had had some experience in regard to joining gas-pipes, and he would state the result. Lead was most unsuitable for this purpose in some respects, though it was universally used. It was expensive; it required caulking or setting up to make it tight, because it contracted on cooling; and if you wanted to remove the pipes—which constantly happened, except in the very largest mains—from the increased consumption requiring larger pipes, the use of lead prevented your getting out the pipes without cutting them, which occasioned considerable loss. Various means had been tried for drawing pipes, but all had failed, and they always had to be cut. Another drawback was that lead, being valuable and easily disposed of, was constantly being stolen. Now this new metal was free from all these disadvantages. The only thing which occurred to him, while listening to the paper, was that it seemed a shame to put so beautiful a substance to so base a use; for when he looked at those beautiful busts, it seemed a pity to use the same material for joining gas-mains. However, it had many advantages for his purpose, not the least of which was its perfect soundness. The account given by Dr. Cole was quite accurate. The four pipes jointed in the Old Kent Road, as described, and supported at the two ends, were exposed to the most severe test, and when he purposely broke one of the joints at the conclusion of the experiment to see what the effect was, he found the metal had taken a perfect impression of the cast-iron. The South Metropolitan Gas Company were now using it instead of lead: the men had no difficulty in applying it, and the only test required was that of time, of which he had no fear. The only possible difficulty was that workmen, being accustomed to use a fierce fire to melt the lead, might make the metal too hot, and so burn the sulphur; but that could easily be guarded against. If required, it could be easily cut out with a chisel in order to remove the pipes; and another advantage was, that if from any cause it did not run quite round a large pipe and make a perfect joint, you could clean out the part which had not been filled, put a fresh piece of clay there, and fill it up with a little more metal, and thus the joint was made quite sound.

Mr. Cresswell wished to ask one or two questions, not with a view to throw a doubt on the utility of the invention, but rather to elicit valuable information. And, first, he wished to compliment Dr. Cole on his paper, which had the rare merit, not only of brevity, but of being written in language so plain that any ordinary person could understand every word. Though brief and simple, it contained matter of considerable importance to the commercial interests of the country, because, if a substitute for lead had been discovered, it would be an immense advantage to everyone, except, perhaps, those interested in lead mines. If, on the other hand, it would serve the purposes of art, he could not conceive a greater boon to the large class of struggling population, who were endeavouring, both male and female, to earn a living by the pursuit of art. He wished to know, in the first place, if this material, if used for jointing pipes, possessed any elasticity; because he was told that it was absolutely essential to the permanence of gas-pipes under the London streets, with heavy traffic passing over it continually, that there should be a certain give and take, or elasticity, in the joints. If, when heavy pressure was brought to bear on these pipes, they gave way at the joint, the value of the joint was reduced to *nil*. In the ordinary way, you first caulked the pipe, then filled it with lead, and thus produced an elastic joint, which would yield to such an extent that you might bend the pipe without destroying the continuity of the joint. If, on the other hand, this metal was so brittle that under any sudden pressure it gave way it would be a formidable difficulty. The next question was this:—He understood there was a project for bringing salt-water to London from the sea, and one of the greatest difficulties, as he was informed, which the promoters would have to deal with was to discover a joint for the pipes which would not be affected by salt-water. If any means could be devised for cementing pipes which would allow of salt-water being conveyed from Worthing to London, and remaining in the pipes for forty-eight hours or more, or even permanently, it would relieve the promoters of this enterprise of a great difficulty, and perhaps confer a boon on the inhabitants of the metropolis.

Captain Heathorn asked if there were any galvanic action between this metal and copper, and also if it had been left for some time at the bottom of the sea to see if barnacles and such things would adhere to it?

Mr. Waller asked if it would expand and contract in the same proportion as water-pipes if used for hot water?

Mr. Spence said the joints would be considerably affected by hot water if the temperature was very high. Ordinary boiling water would not affect it; but, as it melted at about 300°, if there were a steam pressure of about 40 lbs. there would be such an increase of temperature that the joints would not stand. It did possess a certain degree of elasticity. In one case 30 ft. of pipes were connected with this metal at the joints, and deflected to the extent of 8 inches, and when the weight was removed the pipes recovered their original position, showing that it was elastic to some extent. With regard to expansion and contraction he was hardly yet in a position to speak. He would take this opportunity of stating that if ever this metal, as it was called, did take a place in art or industry, much of its success would be due to Dr. Cole, who had greatly assisted him in his experiments and in elucidating the facts; and also to Mr. Livesey, who was the first to take it up in a practical way.

Mr. Livesey said lead was certainly not elastic. If you were to join four lengths of 9 feet together with it, caulking it up in the ordinary way, and then knock out the central supports, the upper part of the joints would squeeze into a narrower compass, and the lower would be left open,

and when the pipes were again brought to a straight line the lead would not return to its original shape. Lead was not elastic in any sense whatever, and it was, therefore, a very bad thing for pipes where there was any settlement or change of position. This metal seemed to have the effect of making the four lengths into one continuous perfect pipe, which had just the same strength in the joints as anywhere else. This was shown by the fact that when supported at the two ends it sagged evenly throughout, making a continuous curve; whereas if the joints had been made with lead, there would have been a number of straight lines, with angles at the joints.

Dr. Cole said he believed that salt-water would have no action on the metal whatever. The same with regard to galvanic action, for which it had been tested. With regard to barnacles at the bottom of the sea, he regretted to say that no experiments had yet been made in that direction. He would conclude by another experiment, to show how quickly the metal set, namely, coating a pat of butter with it.

Whilst this experiment was being performed,

The Chairman proposed a cordial vote of thanks to Dr. Cole, which was carried unanimously.—*Journal of the Society of Arts.*

PHYSICAL SOCIETY.

Annual General Meeting, February 14, 1880.

Prof. W. G. Adams in the Chair.

The President read the report for the past year, which showed that the position and prospects of the Society are in every way satisfactory, and that more papers were communicated during last year than in any previous year. The following list of Council and Officers was elected for the ensuing year, and votes of thanks were given to the President, the Lords of the Committee of Council on Education, and to the Treasurer, Demonstrator, and Secretaries:—President, Sir W. Thomson, LL.D., F.R.S. Vice-Presidents, Prof. W. G. Adams, M.A., F.R.S. (who has filled the office of President); Prof. R. B. Clifton; Dr. Huggins; Lord Rayleigh; Dr. Spottiswoode. Secretaries, Prof. Reinold and Mr. W. Chandler Roberts, F.R.S. Treasurer, Dr. Atkinson. Demonstrator, Prof. Guthrie. Members of Council. Captain Abney; Walter Bailey, M.A.; J. H. Cotterill, F.R.S.; Dr. Warren de la Rue; Major Festing, R.E.; Prof. G. C. Foster; Prof. Fuller; Dr. J. Hopkinson; Dr. Schuster; G. Johnstone Stoney, F.R.S. Honorary Member, J. E. R. Clausius.

After this business the meeting resolved itself into an ordinary one, and the following new Members were elected:—Senor Roig y Torres, of Barcelona, Mr. Mollison, Mr. Hare, Mr. J. C. Lewis, Miss Carolina Martineau.

A paper, "*On a Quartz and Iceland Spar Spectroscope Corrected for Chromatic Aberration*," was then read by Dr. W. H. Stone. The spectroscope consists of two Iceland spar prisms and a quartz train. It differs in no respect from those ordinarily made, except in the fact that the object-glasses of the telescope and collimator are doublets, with a positive lens of quartz and a negative of Iceland spar. The latter has a dispersive power so far greater than that of quartz that an approximation to achromatism may be easily obtained. In a spectrum there is less fear of indistinctness from superposition of images than in a telescope; but a greater amount of focussing is required with unachromatic lenses, insomuch that lines in the field at one time need alteration to obtain distinctness. Moreover, it is an obvious advantage to transmit the whole of the rays coming from the collimator as nearly as possible parallel through the intra-objective space and the prisms. The object-glasses were made by Mr. Ahreas about four years ago, and sent to Prof. McLeod. They were put aside, but have been recently re-mounted owing to M. Cornu having recently published a similar device.

A paper, "*On an Automatic Switch for Telephone Circuits*," was then read by Dr. Wynne. The object of th switch was to enable any client of a telephone exchange to communicate with any other through the central office without the need of an assistant at the office.

Mr. Varley and Prof. Ayrton criticised the device, and the latter thought that the contacts might not be always reliable.

Profs. Ayrton and Perry then read a note on their "*Theory of Terrestrial Magnetism.* Prof. Rowland, of Baltimore, had pointed out an error in their calculation which vitiated their results, and they therefore admitted that the charge of statical electricity on the surface of the earth assumed by them as competent to account for the earth's magnetism was not sufficient to account for the whole but only a portion of that magnetism. Nevertheless, they thought that the changes in the distribution of such a charge, due to changes in the condition of the dielectric medium between the earth and the sun, might account for the observed perturbations in the magnetic elements.

CORRESPONDENCE.

CUPRIC TEST-PELLETS.

To the Editor of the Chemical News.

Sir,—In regard to the account of cupric test-pellets for sugar (Chemical News, vol. xli., p. 63) it seems to me that Dr. Pavy is not aware that the difficulty of preserving Fehling's solution is entirely overcome by keeping the cupric sulphate and alkaline tartrate in solution in separate bottles. Thus, instead of, for instance, dissolving the required quantity of cupric sulphate, then adding the necessary amounts of Rochelle salt and caustic potash or soda, and making up to *one litre*, the same quantity of cupric sulphate is dissolved and made up to half a litre, and the corresponding quantities of Rochelle salt and caustic potash are also dissolved to half a litre, and the two solutions kept in separate bottles. When required, 10 c.c. (say) are withdrawn from each bottle and mixed, when 20 c.c. of Fehling's solution is formed. When so used the strength suffers no deterioration whatever. I have used it in this manner for some time past with accurate results. As to the stopper of the alkaline tartrate becoming a little fixed, this is no more serious than what occurs every day with a bottle containing caustic soda, and can, if desired, be avoided by using caustic potash instead of caustic soda in the preparation of Fehling's solution.

As to Dr. Pavy's pellets, I am of opinion that their application quantitatively would be attended with serious difficulties, such as loss of weight by friction, &c.—I am, &c.,

W. O. Glassford.

The Brewery, St. Helens,
February 10, 1880.

TESTING VITRIOL CHAMBER EXITS.

To the Editor of the Chemical News.

Sir,—I was astonished to see in your issue of Feb. 6 letters from Messrs. G. E. Davis and W. J. Lovett, which imply that I had pirated from Mr. Davis the idea contained in my letter on the "Testing of Vitriol Chamber Exits" (Chemical News, vol. xli., p. 47). I thought that I had given Mr. Davis every credit due to him. He will not have forgotten that when on one of his official visits to these works in May, 1879, I mentioned to him, as a new process, the method for estimating the N compounds by the mercury tube or nitrometer, which I had just begun to use, he invited me to read a paper on it before the Faraday Club. This would of itself have led me to think that the method was new if I had not thought so before. The

twenty-two and a half hours aspiration of exit-gases which I performed for Mr. Davis I understood to be for ascertaining the persistency of H_2O_2 in dilute aqueous solution.

In answer to Mr. Lovett's letter I am obliged to say that the only part of it to which I cannot take emphatic exception is the conclusion, where he is good enough to copy from my letter my opinion, and reasons for that opinion, as to the inaccuracy of the indirect method of determining the N compounds. In the first place, Mr. Lovett was not present at the meeting of the Faraday Club at which the paper of Mr. Davis referred to was read. Then it is extremely surprising that, notwithstanding his connection with Mr. Davis, and therefore presumably long previous acquaintance with the nitrometer method, he should have continued to use, at the Victoria Chemical Works, the old inaccurate process long after he succeeded me there in May, 1879, and that when he first introduced the method I have described the results were so incorrect as I understood at the time they were. I must therefore call upon Mr. Lovett or the works' chemist to say *when* the nitrometer method was introduced by Mr. Lovett to the laboratory of the Victoria Chemical Works; how the process was at first worked so as to give unreliable results; and how it came ultimately to be worked correctly.—I am, &c.,

T. E. Vasey.

Church Street Chemical Works,
Hunslet, Leeds, Feb. 10, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 4, January 26, 1880.

Levulosate of Lime.—E. Peligot.—The products resulting from the action of alkalies upon levulose are those obtained by the action of the same bodies upon the glucose obtained from the saccharification of starch. They are the more complex, the more the air intervenes in the successive transformations.

Notes on the Acids formed on Re-distilling the Crude Fatty Acids in a Current of Superheated Steam.—A. Cahours and E. Demarçay.—In this process there are formed the different terms of the fatty series from the acetic to the caprylic acids inclusively. The authors hope to demonstrate the presence of the higher members, such as the pelargonic and capric. Acids of the succinic series appear also to be produced.

Photography of the Ultra-red Portion of the Solar Spectrum.—M. Abney.—A description of a photograph laid before the Academy.

Density of Chlorine at High Temperatures.—J. M. Crafts.—The author criticises the researches of V. and C. Meyer. The only experiment of theirs which he has repeated under the same conditions has yielded a result analogous to theirs. He agrees with them that at the highest temperature of the Perrot furnace, iodine decreases in density and augments in volume in the proportion of 1 to 1·5 as compared with air.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. No. 17, 1879.

Amido-Acids with Alcohol Derivatives.—P. Griess.—This paper is devoted to a consideration of trimethylated sulphanilic acid.

Action of Methyl-iodide upon Asparargin.—P. Griess.—The author has obtained a new acid, $C_4H_5NO_3$, and has examined some of its salts.

Action of Cyanogen Compounds upon Diazobenzol.—P. Griess.—Finding that H. Gabriel is engaged with the study of this action, the author desists from the further prosecution of his researches save as regards the compounds formed by diazobenzol with hydroferricyanic acid and hydro-nitro-prussic acid.

Action of Diastase upon Starch Paste.—A. Herzfeld.—We have here a special description of the final products of this reaction, maltose and achroodextrin. The author has acetylised erythro-, achroo-, and malto-dextrin, as also cane- and milk-sugar, maltose, and dextrose.

Atomic Weight of Antimony.—J. P. Cooke.—A reply to H. Kessler.

The Constitution of Anthraquinon.—H. v. Pechmann.—This paper contains an account of ortho-bromphthalic acid, of ortho-brom-benzoyl-benzoic acid, ortho-brom-anthraquinon, and erythroxy-anthraquinon.

The Spontaneous Decomposition of Dichlor-ethylamin.—J. Tscherniak.—The author adheres to his former assertion that perfectly pure dichlor-ethylamin can be preserved undecomposed for an indefinite time.

The Luminous Nature of Phosphorus.—W. Müller-Erzbach.—The author, as against Joubert, claims a priority in the announcement that the luminosity of phosphorus is entirely due to the combustion of its vapour.

The Reduction of Metallic Oxides by Hydrogen.—W. Müller-Erzbach.—Referring to a paper by Messrs. Alder, Wright, and P. Luff (*Jour. Chem. Soc.*, for 1878, xxxiii., Part 1), the author points out that he published a paper on this subject in 1869 (*Poggendorff*, 136, p. 64), containing results similar to those subsequently obtained by the above-mentioned chemists.

Reduction of Carbonic Acid by Phosphorus at Common Temperatures.—A. R. Leeds.—The author in correction of a former paper, remarks that in his experiments, large quantities of phosphoretted hydrogen gas were formed, the reducing powers of which were overlooked. He has not succeeded in confirming the reduction of carbonic acid to carbonic oxide.

An Exhaustive Chlorination of Iso-dinaphthyl.—Watson Smith.—Not suitable for abstraction.

The Relations between the Physical Properties of Organic Bodies and their Chemical Constitution.—J. W. Brühl.—An extract from the author's paper in *Liebig's Annalen*.

Reimann's Färber Zeitung, No. 2, 1880.

Storck and Strobel employ the sulphocyanides as resist for aniline-blacks. They destroy the oxides of chlorine, by whose action upon the salts of aniline the black colour is produced. Hence, wherever the sulphocyanides are printed on, the formation of aniline-black becomes impossible.

MISCELLANEOUS.

The Academy of Sciences.—An extraordinary prize of 3000 francs has been awarded by the French *Academie des Sciences* to Mr. Crookes, F.R.S., in recognition of his recent discoveries in Molecular Physics and Radiant Matter.

NOTES AND QUERIES.

Sweep Smelting.—Can any of your correspondents tell me of a good book on this subject.—J. L. Clarke, Philadelphia.

Solvent Power of Gases.—Kindly tell me where I can find a good account of Hannay's (or other) researches on the solvent power for solids possessed by gases when under pressure and heated.—G. A. Keyworth.

Schaffner's Glass Reaction Wheel.—If the enquirer will communicate with Mawson and Swan, Newcastle-on-Tyne, his requirements will be attended to.

THE CHEMICAL NEWS.

Vol. XLI. No. 1057.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 84.)

V. On the Use of the Periodic Law for the Correction of Atomic Weights.

Everybody knows the fate of Prout's hypothesis. Careful observations having proved that the numbers of atomic weights can contain fractions—Stas having shown that definite fractions cannot be admitted—we can no longer entertain any doubts, in spite of Marignac's brilliant opposition, but that Prout's hypothesis overstepped the facts. I cannot even see how any reasonable argument can support it. Let us admit that the matter of all the elements is completely homogeneous: there is no reason why we should also admit, that n ponderable particles, or n atoms of an element, in changing into one atom of a second element, will give the same n ponderable particles, or that the atom of the second element will be n times as heavy as the atom of the first. We can consider the law of the invariability of weights as a special case of the law of the invariability of force or of motion. The cause of weight is evidently a particular kind of movement of matter, and there is no reason for denying the possibility of transforming these movements into chemical energy, or into some other form of movement. Two phenomena which we can now notice in the elements, viz., the invariability and the indestructibility of the atomic weights, are, up to the present, in intimate and even historical relation. If, then, a known element was to decompose itself, or if it was to change into another one, these phenomena might be accompanied by a diminution or an increase in weight. In this manner can be explained, up to a certain point, the difference of the chemical energy in different elements. In expressing this idea here I wish to say *only* that there is some possibility of the opinions of chemists on the composed nature of elements becoming uniform without adopting Prout's hypothesis.

From a practical point of view, Prout's hypothesis is defective, in so far as it concerns directly, small numbers. Our usual determinations of atomic weights do not often agree to a fiftieth part with the whole number, often even to nearly five or six units, whilst in Prout's hypothesis it is only a question of tenths. Thus, as we have already seen, the different determinations of the atomic weight of titanium vary from 57 to 48.

But from a theoretical as well as from a practical point of view, it is very important to have a principle which will lead to the discovery of the great errors which are sometimes made in the determination of atomic weights, and to have an idea of greater numbers. If in these last we discover a true regularity, it is certain that eventually we shall discover such a regularity that will enable to determine theoretically, and with great precision, the magnitude of atomic weights. The periodic law, even in its present state, enables us to discover moderate errors in the determinations of atomic weights, as we have seen in the case of titanium. We are now going to give examples of a more rigorous nature.

To correct atomic weights exactly it is necessary to submit the individual properties of elements to an exact and comparative examination, for it is these properties which cause the perturbations in the regular variations of the amount of the atomic weights. Already, in the preceding pages, I have noticed the evident existence of such properties. The absence of an exact regularity in the variations of atomic weights arises from two comparisons.

It arises, first, from the fact that the differences in the magnitudes of atomic weights of corresponding members of different series and different groups are far from agreeing, even if we take into account the admissible errors of determination. Thus, the difference between the atomic weights of Na and Li, or, for the sake of brevity, Na − Li = 16, as also K − Na = 16, but Mg − Be = 14·6; on the other hand, Ti − Si = 20, V − P = 20, Pt − Pd = 91, Au − Ag = 89, Hg − Cd = 88, Pb − Sn = 89, Bi − Sb = 86. It is difficult to admit that the gradual diminution of the differences is only a matter of chance. We ought rather to think that the relation between Pt and Pd is not altogether the same as that between Bi and Sb, and therefore the differences cannot be the same. We might notice that the properties of Bi and of Sb differ by a certain number of individual characters, whose origin arises in the slight individual separations of their atomic weights.

A second proof of the fact that periodic differences are in reality irregular, is found in the precise determinations of the atomic weights of the alkaline metals and the haloids, which were done by Stas.

If H = 1 and O = 15·96		
Li = 7·004 }	difference	15·976
Na = 22·980 }		
K = 39·040 }	,,	16·06
Cl = 35·368 }	,,	44·382
Br = 79·750 }		
I = 126·533 }	,,	46·783

Wemust see that there is a strict comparison in the differences between the values of the atomic weights of elements that correspond in the system, but we also notice by the side of these comparisons individual separations. Therefore the elements possess general properties, dependent periodically on their atomic weights (for example, the property of given determinate forms of oxidations, which are modified spontaneously and gradually), and individual properties which are determined by the separations mentioned above.

We do not really know anything of the just-mentioned relation, except the periodic property; and even this one is not properly understood. It is therefore impossible to determine exactly the amount of the separations, any more than we can correct positively the magnitude of atomic weights. We can only determine limits, certainly very near together, between which the amount of the atomic weight of a given element should be.

According to the periodic law, the atomic weight of tellurium should be greater than that of Sb = 122, and less than that of I = 127; that is to say that the atomic weight of tellurium ought to be about 125, because from every point of view, atomic analogies assign it a place between Sb and I. Considering that Ag − Cu = 45, that Cd − Zn = 47, that Sb − As = 47, that I − Br = 47, that Cs − Rb = 48, that Ba − Sr = 50, we are led to presume that in the same manner Te − Se = 47 (nearly), for Te is found between Sb and I, as Se is between As and Br; and as Se, whose atomic weight is 78, has been more completely studied, and can be more easily purified than Te, the number found for Se should be accepted before the atomic weight found for Te; this is why this latter should be about 78 + 47 = 125. This result does not agree with the numbers last given by Berzélius (who determined the quantity of TeO_2 obtained by the oxidation of Te by means of nitric acid).

O = 15·96,	O = 16·0
Te = 128·13,	Te = 128·45
= 127·97,	= 128·28
= 127·96,	= 128·28

Hauer (who estimated the bromine of K_2TeBr_6 as AgBr) obtained corresponding numbers; still, Te is generally taken to be = 128. Further, as the first determinations, made by Berzélius (1812), gave the number 116, as the later experiments have given the number 129, the exacti-

tude of the actually recognised atomic weight gives rise to certain doubts, which can only be eliminated by fresh experiments. It is difficult to purify the compounds of tellurium, and even to be certain when they are pure. This may perhaps explain in a measure the errors of the numbers which have been found. It is difficult to admit that the distinctive individual characteristics of tellurium could determine a gap relatively so great (128 to 125) compared with the number of its atomic weight, as it is deduced from the periodic law. Fresh experiments are therefore necessary to show us to what degree the periodic law can be relied upon in the correction of atomic weights.

Os, Ir, and, perhaps, also, Pt and Au, furnish us with a second example of gaps of this nature. These elements are found in the same series of the system (see Chapter I.); they are preceded by W = 184, and followed by Hg = 200. Their atomic weights are effectively less than that of Hg, and greater than that of W, but the series does not correspond. For, considering that Os, Ru, and Fe are analogous, but that the atomic weights of Ru and Fe are less than the atomic weights of Pd and Ni, we can foresee that the atomic weight of Os will be less than that of Pt, so that Ir, which is between Pt and Os, will be intermediate. According to Berzélius and Frémy, Os = from 199 to 200, Ir = 197, Pt = 198. The predicted series is the following:—Pt = 198,* Ir = about 197, Os = from 196 to 195, whilst Au will be equal to 199.

Besides, it is allowable to suspect errors in the determinations of the atomic weights of the metals of the platinum group, not only because it is difficult to separate them one from another, but also because the compounds which are used for these determinations are very unstable; $IrCl_4$ and $OsCl_4$, for example, easily lose a part of their chlorine.

(To be continued.)

ON SOME OF THE

EFFECTS PRODUCED BY AN INDUCTION-COIL

WITH A

DE MERITENS MAGNETO-ELECTRIC MACHINE.†

By WILLIAM SPOTTISWOODE, P.R.S.

IN the *Philosophical Magazine* for November of last year I gave an account of a mode of exciting an induction coil by the direct application of one of M. de Meritens' alternating machines, without the intervention of a contact-breaker or the use of a condenser. The experiments of Prof. Dewar on the arc furnished by the machine itself on its spectrum, and on its behaviour in respect of electrolysis, described before the Royal Society (see *Proceedings*, Feb. 13, 1880), have led me to think that an account of some of the peculiarities in the induced discharge, to which the machine gives rise, might be acceptable to the Society.

And, first, as regards the secondary discharge in air. It was mentioned in the paper first quoted that the spark produced by this machine presented an unusually thick yellow flame, and that it was accompanied by a hissing noise different from that commonly heard with a coil excited by a battery. As the machine gives alternate currents, the secondary discharge presents sparks of equal strength in both directions, and the general appearance to the eye is symmetrical in respect of both terminals. The spark was observed in a revolving mirror, first in a vertical and secondly in a horizontal direction. The discharge, although apparently continuous, was immediately seen to be intermittent, with a period in unison with that of the machine. Tongues of flame, leading alternately from one terminal and from the other, crossed the field of view. The length of spark first used (vertically) was about half an inch. When the length was increased to about two inches, flashes or bands of continuous light were seen to traverse the field of view in diagonals of low slope (*i.e.*, nearly horizontally), showing that there were masses of heated matter passing from time to time at moderate velocity between the terminals. From the known period of the machine, and the number of the discharges crossed by these flashes in their passage from terminal to terminal, it was calculated that the time of passage was about 0·03 of a second. Occasionally there was a still brighter flash or meteor, which similarly traversed the field, but with a velocity apparently of about double that of the others.

When the discharge was set horizontally, similar phenomena were seen; but at a distance about midway between the two terminals the flames appeared to meet, and at their point of meeting they showed continuous luminosity throughout. When the flame was blown aside, there appeared occasionally, and at rather long intervals, the true spark, evinced by an irregular bright line, reaching from one terminal to the other.

On observing the discharge in air attentively, it was noticed that whenever a true spark passed its passage was marked, as usual, by an irregular bright line when its path was outside the aureola or flame, but by a similar dark line when its path was within the aureola. Whether this be a merely subjective effect, due to the fatigue of the nerves of the retina by the bright spark, which always precedes the aureola in point of time; or whether it has any electrical significance, perhaps requires further examination.

The spectrum of the secondary spark was then examined with terminals of various metals.

Aluminium.—The spectrum showed a faint continuous background with the yellow sodium lines, and faint oxide of aluminium lines. This was with a spark of half an inch. But although the spark was subsequently lengthened, no difference in the spectrum was perceived excepting that the continuous background was rendered more bright.

It would seem that these appearances are due to some such process as the following:—The heat due to oxidation, added to that of the discharge, is sufficient to volatilise the oxide of aluminium; but that in its passage across the interval between the terminals, the oxide becomes so cooled that it gives a continuous spectrum. When the spark was lengthened, the oxide, although perhaps at first more heated than with the shorter spark, had more time to cool.

Magnesium.—In this, as in the former case, we have a faint continuous spectrum as a background, on which were seen the *b* group of magnesium lines. One other line in the blue occasionally flashed out, but was not permanently present. There was also a faint trace of the oxide spectrum. The contrast between the cases of aluminium and magnesium, in respect of the prominence of the oxide, or of the true metallic spectrum, is doubtless due to the fact that in the former case the oxide, and in the latter the metal, is the one which is more easily vaporised. On sending a blast of air on the discharge, the blue line always disappeared; the current of air having lowered the temperature so far as to prevent the vaporisation necessary for its production.

When the spark between magnesium terminals was made to pass through hydrogen, the characteristic lines of hydrogen were seen, apparently owing to a rise in temperature. This, as mentioned below, does not occur with carbon poles.

Platinum.—With terminals of this metal the spectrum was mainly continuous, with the addition of the ubiquitous yellow sodium lines. When the spark was short a few bands were faintly visible, some apparently these of nitrogen, and others in the blue and violet belonging to the oxide of platinum. When the spark was lengthened, these bands dissapeared, and nothing but the continuous spectrum (with the D lines) was visible.

It appears from these experiments that the application of the De Meritens machine to the induction coil furnishes

* According to Berzélius, 198; according to Andrews, 197·88.

† A Paper read before the Royal Society, February 19, 1880.

us with the means of isolating certain lines of the metallic spectrum from the rest. It has, in fact, enabled us to reduce at pleasure the spectra of aluminium, of magnesium, and of platinum, to their most persistent lines; precisely as had already been noticed as occurring by natural processes in the cases of sodium and of calcium. As a general rule, when the spark is shortened the metallic, or the oxide, lines come out, when it is lengthened they disappear.

From this we may conclude (1) that the discharge which we have been examining is a real flame with metallic particles passing between the terminals in a solid condition; and (2) that in general the temperature is comparatively low, *i.e.*, that it is sufficient to cause any considerable vaporisation. This is notably the case when the arc is long, and when the matter thrown off from the terminals has sufficient time in its passage to cool.

The spark was then tried between carbon terminals in atmospheres of hydrogen and of carbonic acid. In none of them did the spectrum show any gas lines; but with hydrogen there were faint traces of the hydrocarbon group in the green. In this respect the spark differs from the discharge direct from the machine, inasmuch as the latter gives some of the hydrogen lines in hydrogen and carbon lines in carbonic acid.

When the spark was discharged in a magnetic field, known phenomena were reproduced, but owing to the thickness and mass of the flame and the extraordinary strength of the magnetic field, they were exhibited in a state of great splendour.*

When the spark passed in an equatoreal direction the whole flame was spread out in an equatoreal plane, in which heated masses might be seen revolving in one direction or in the other in the neighbourhood of each of the magnetic poles. To give some idea of the actual appearance, it may be mentioned that a symmetrical spindle-shaped discharge, 15 m.m. in length and 3 m.m. in thickness, was spread out by the magnet into a disk of about 15 m.m. in diameter and 1 m.m. in thickness. When the spark passed in an axial direction, or when the poles themselves were made the terminals, the phenomena described in my paper "On an Experiment in Electro-Magnetic Rotation" (*Proc. Roy. Soc.*, March 30, 1876) were reproduced.

Whatever was the direction of the spark, the resistance due to the magnetic field was such as to extinguish the discharge, provided that the striking distance was near the limit that it could attain when no magnetic field was present. If a plate of glass was interposed between the poles of the magnet (which were still used as terminals) the yellow flame disappeared, and the spark divided itself into numerous ramifications of true sparks which found their way round the eges of the plate. As soon as the magnet was excited the resistance in the field became so great as to exceed that of the glass plate itself, and the plate was pierced.

When magnesium terminals were used in an atmosphere of hydrogen, the yellow sodium lines, the blue and green magnesium lines, and the red line of hydrogen were visible near the terminals, with a continuous background. When the magnet was excited, the only change observed was that the lines became slightly fainter.†

Professor Dewar was good enough to measure the efficiency of the secondary discharge, by taking an inch spark in a glass bulb placed in the centre of a calorimeter, in the same way as he had already measured the efficiency of the intermittent current direct from the machine. The former amounted to about 430 gramme-units per minute, while the latter had been found to be 6000 per minute. The relative efficiency may, therefore, be taken at about 1 : 15. And as the machine was giving about 300 currents per second, this would give for the secondary—

$$430 : 60 \times 300 = 0{\cdot}023 \text{ unit per discharge,}$$

and for the primary—

$$6000 : 60 \times 300 = 0{\cdot}3 \text{ unit per discharge.}$$

The results in the case of the secondary discharge may not perhaps possess any great degree of accuracy; but, in the absence of any other information on the question, they may serve to indicate the general scale of magnitude by which the coil discharge is related to that of the machine.

Leaving the subject of the spark from the induction coil, one of the most remarkable effects produced by this machine was the illumination of vacuum tubes by the currents taken simply from the machine. A small sphere of about 2 inches in diameter, with an air-vacuum, and having two parallel straight terminals reaching nearly across the sphere and about half an inch apart, was (after the first attempt, when there was some difficulty in getting the discharge to pass) readily illuminated. Owing to the alternate currents, both terminals were of course surrounded with the usual blue halo. When the speed of the machine was reduced, the discharge through the tube was not maintained, showing that only that part of the current from the machine which possessed the highest electromotive force, and perhaps also the greatest strength, was sufficient, and was therefore actually used for the purpose. As this was apparently only a small fraction of the whole current, we may herein find an explanation of the fact that, compared with the effect from the induction spark, the illumination was moderate and the heating insignificant. It would, perhaps, not be easy to establish an accurate comparison between this and other sources of electricity; but some idea may be conveyed by the fact that, from experiments made with this tube with Mr. De la Rue's chloride of silver battery on a former occasion, and quite independently of the present question, it was estimated that a current having an electromotive force of 400 volts was necessary to effect a discharge.

Other tubes were tried, and were illuminated in the same way.

When the tube was placed in the magnetic field the discharge underwent the modifications described by Plücker, by Hittorff, and by others. But it may be mentioned as a result of the extraordinary strength of the field here employed that, whenever the tube was so placed that the direction of discharge made any considerable angle with the lines of magnetic force passing through it, the discharge was completely extinguished. Whe the tube was removed to a weaker part of the field the discharge reappeared distorted in form, and altered in colour in a manner known to those who have experimented in this direction.

* Through the kindness of the Royal Institution, Faraday's great electro-magnet, excited by the Siemens machine, was placed at my disposal.

† There was some reason to think that, at the moment of making the magnet current, the lines became decidedly brighter, and that they lost their brilliancy if that current was maintained. But this, perhaps, requires further examination.

ON THE USE OF THE SPECTROSCOPE IN DISCRIMINATING ANTHRACENS.

By BENJ. NICKELS, F.C.S. F.I.C.,

(Continued from p. 52.)

In the application of crude anthracen to the production of artificial alizarin and anthrapurpurin—the latter especially—considerable difficulties have been encountered, not only in estimating the actual amount of colour-yielding material present in a given sample of crude anthracen, but in eliminating associated and useless substances which for the time being stand in the position of impurities. Without entering upon the long and complex list of hydrocarbons passing over in the ordinary process of tar distillation, associated more or less with every product derived from it, but more especially with anthracen, sufficient is known to point with some degree of judgment to

the selection of appropriate samples, and as best adapted to the particular line or process to be followed.

The presence of high fusing-point hydrocarbons is known to offer considerable impediment to the commercial production of high quality anthracens, irrespective of the process followed, whether of washing or sublimation, and such as will ultimately be required under more simplified methods of converting that product into colouring matter. These bodies—classed under the broad and general term of "pyrene" and "chrysene"—are amongst the last in the series that pass over during the usual process of distillation, and do not make their appearance till long after anthracen: the mere term, however, as expressive of these substances is ambiguous, as other hydrocarbons, equally objectionable, are present in the products distilling over, many of them, there is good reason for believing, yet unrecognised. From the fact that these bodies are objectionable, and even prejudicial, in the subsequent processes to which the anthracen has to be submitted, it becomes desirable to possess a simple method of determining their existence, present or otherwise, in a given sample. The fact that most of them yield "quinons," exhibiting well-marked and characteristic qualities, is to an extent some indication, and would perhaps be all that was necessary were their separation when mixed or associated an easy task. Such, however, is not the case; and the more we approach the examination of these substances in admixture with anthracen the more do we approach problems extremely difficult of solution.

During a somewhat extended experience in the manufacture of artificial alizarin and anthrapurpurin in this country, I have, in common with many others, devoted much time and careful attention to the vexed question of anthracen testing, and have long felt that an expeditious method of examining a given sample submitted for analysis, and without the expenditure of time necessary in wading through the recognised tests, private or otherwise, would be of practical utility—a test that should readily indicate the presence or absence of objectionally high fusing-point hydrocarbons, and in doing so lead up to the question, How came they there? by admixture or otherwise? or from intentionally running a still beyond the limit for good anthracen?

Such a test was originally hinted at by Professor Morton (United States) in a valuable and exhaustive series of papers published in the Chemical News as far back as the year 1872 (vol. xxvi., p.199), following into December, and appearing again in January, 1875 (vol. xxxi., pp. 35, 45). In the later communications it was even suggested that the method followed might be of "some moment in its bearing upon the discrimination of anthracens and associated bodies." So far as my information serves me, it would not appear that any practical advantage has been taken of this publication, so strongly commending itself to those engaged in the examination and testing of commercial anthracens.

My own experience in the use of the spectroscope in the direction indicated dates some two years back, and at which period I had commenced the examination of the various substances fractionally separated from coal-tar by distillation, and had made considerable progress with the research, when my attention was called to the papers in question. As a matter of fact, I perused them with much interest, the more so inasmuch as my own observations had indicated that the instrument named would, within a certain limit, serve an important purpose in examining anthracens, doubtful or otherwise.

The mode of research, or rather method, followed by Professor Morton was, as will be found on reading over his interesting papers, too complex for ordinary technical purposes, and such as could only be conducted in physical laboratories. The instrument used was a Browning "one prism spectroscope," and the substance to be examined prepared by "melting with paraffin and pressing between slips of glass." The special form of instrument employed, however, was not well suited for the detection of delicate absorption-spectra, its dispersive power being too high; simpler forms of instrument are at our disposal, and admirably fulfil all the conditions that could be desired.

The point of interest in the communication of Professor Morton undoubtedly lays in the fact that attention was called to some remarkable absorption-spectra obtained after much care and seeking, and which he considered to be "chrysen," employing material specially prepared from tar distillations made at the works of Messrs. Page, Kidder, and Co., of Bull's Ferry: furthermore, that if not directly attributable to "chrysen itself, it was to an associated substance or impurity" which he had not succeeded in separating. To this question I have since given much attention, and from the fact that my results, following closely in a similar direction, hade pointed to associated bodies of still higher fusing-points, as those yielding the observed spectra, I have been induced to view this mode of research as a valuable preliminary test and adjunct to known methods of examining crude or commercial anthracens. Broadly, it may be stated that ordinary yellow chrysen crystallises in minute lemon-yellow laminæ, presenting a magnificent fluorescence, and fusing at 250° C. If we prepare a solution of this hydrocarbon in benzol, and compare it with similar solutions of naphthalin, acridin, carbazol, phenanthren, anthracen, and pyren, employing a suitable instrument for the observation, we find a remarkable departure in the case of the chrysen solution. Each of the preceding substances named present a clear and continuous spectrum, whereas yellow chrysen exhibits superb absorption-bands, broad and deep, two of them placed between the F and G lines, and one immediately to the left of the G line (commencing with D to the right).

In prosecuting these experiments I have found that the substance affording these bands is not chrysen, but (as may already have been observed, although I am unacquainted with any publication) to the presence of an associated body, and to which its intense yellow colour, as already conjectured, is due. Pure white chrysen presenting the same pearly lustre as anthracen, and equally fluorescent, fusing at 248° to 249° C., affords no absorption-spectra, those previously observed in the yellow variety having entirely disappeared.

The associated and colouring substance when isolated presents remarkable features, soluble with difficulty in high boiling-point naphtha; it crystallises in golden-yellow metallic looking plates, with a fusing-point of 280° C.; both as a solid and in solution it presents a superb greenish fluorescence, and contains nitrogen either as an element of constitution, or of a still further associated compound yet undetermined. The additional points of interest resulting from the work carried out lead me to the conclusion of my paper, and to state that during the period named I have examined spectroscopically some hundreds of samples of commercial anthracen, distilled and sublimed, English and foreign, and of all works. Many commercial samples, especially as originally made, and indicating a quality of 40 per cent and upwards by chinon test, exhibit no absorption-spectra or bands: some specimens show them only faintly, and these undoubtedly rank amongst the better qualities; others, and by far the greater number of modern makers, exhibit them broad, heavy, and deep. For comparison of spectra I have been accustomed to use a Browning micro-spectroscope; but for the majority of observations a Browning direct-vision "Miniature," or pocket instrument, offers all that can be desired, and possesses the advantage of being so simple in its use that the most inexperienced operator may easily familiarise himself with its application.

For the guidance of those interested in these results I append the following particulars:—A few grains of the sample to be examined are placed in a test-tube, a little benzol added, and warmed so as to dissolve the contained anthracen. Finally it is made up to about 6 c.c. with more benzol, and passed through a paper filter to remove water. The spectroscope, previously focussed, is then brought to the eye, and the tube of anthracen solution also into close

proximity with the adjusted slit of the instrument. On looking through the solution, and with a good back light, absorption-bands, if present, are seen as fine lines or bars crossing the spectrum, and in the position of those already indicated, the depth or intensity of which assist the judgment in its conclusion.

Specimens of the pure substances may be had on calling at my laboratory, or of Mr. John Browning, the optician, 63, Strand, London, who has kindly prepared a number of these samples in sealed tubes for spectroscopic examination.

104, Leadedhall Street, E.C.

A SERIES OF ANALYSES OF AIR.

By H. MACAGNO,
Director of the Agricultural Station, Palermo.

For sanitary purposes I have had occasion to undertake a series of examinations of air in this town (Palermo, Italy) at its Astronomical Observatory, 72 metres above sea-level.

The analyses were made by the following methods:—

Oxygen, by pyrogallic acid solution and potash.

Carbonic Acid, by the increase of weight of caustic potash solution, after the passage of a known volume of air.

Ammonia, *Nitrates*, and *Organic Matters*, by the analysis of water collected from a set of wash-bottles, through which a measured quantity of air was drawn. The ammonia was determined by the Nessler test, the nitrates by the indigo process, and the organic matters by permanganate of potash in alkaline solution at the boiling-point of water, taking 1 of crystallised permanganate equal to 5 of organic matter (Wood, Kubel, &c.).

The results of the following Table are expressed in litres and grammes, and are referred to 100 litres of air in normal condition, namely, at 0° of temp. C. (32° F.), and 760 millimetres of pressure.

Date of Analysis. 1879.	Oxygen.	Carbonic Acid.	Nitric Acid.	Ammonia, NH_3.	Organic Matters.	For 10 Days. Mean Temps. C.	For 10 Days. Rain-fall in m.m.
	Litres.	Litres.	Grms.	Grms.	Grms.		
Feb. 10	—	—	—	—	—	12·4	11·58
,, 20	20·879	0·021	—	0·024	0·154	13·6	17·29
,, 28	20·891	0·048	—	0·028	0·127	12·8	3·57
Mar. 10	20·715	0·025	—	—	0·115	9·8	9·24
,, 20	19·994	0·025	—	—	0·094	13·3	—
,, 31	20·888	0·022	—	—	0·070	14·4	30·61
April 10	20·910	0·021	—	traces	0·076	14·3	32·01
,, 20	20·880	0·064	—	—	0·094	15·8	18·45
,, 30	20·898	0·045	—	—	0·055	16·0	14·75
May 10	20·913	0·005	—	—	0·020	14 6	17·20
,, 20	20·902	0·049	—	—	0·072	14 0	16·65
,, 31	20·017	0·033	—	0·036	0·142	19·8	2·23
June 10	20·894	0·041	—	—	0·107	20·5	—
,, 20	20·918	0·043	—	0·040	0·363	22·0	—
,, 30	20·915	0·043	—	0·009	0·162	23·5	—
July 10	20·977	0·020	traces	0·010	0·111	23·4	—
,, 20	20·984	0·076	—	0·080	0·157	22·6	—
,, 31	20·899	0·039	—	—	0·138	23·0	—
Aug. 10	20·910	0·028	traces	0·005	0·165	25·1	—
,, 20	20·888	0·030	—	0·007	0·112	25·1	—
,, 31	20·895	0·039	—	0·009	0·131	25·0	—
Mean Results.							
February, March, April, May (with rainfall)—	20·717	0·033	0·000	0·008	0·102	14·2	173·18
June, July, and August (without rainfall)—	20·920	0·039	traces	0·009	0·160	23·4	0·00

The observations made on the air of Palermo in different seasons, as above described, cannot fail to attract the attention of the analytical student of nature. And, first, they show, as regard organic impurity and carbonic acid, an increase with augmentation of temperature, which is the principal factor of all putrefactive changes in nitrogenised or ammoniacal matters. Secondly, we cannot but observe the influence of rain as a great air-washer. Rain dissipates the deleterious gases which accumulate and float over towns and cities. It brings down from the higher regions of the atmosphere a more salubrious air, and by the flushing of drains and cleansing of the surface of the country, aids in preventing the contamination of air by the exhalations of animals, and by the decomposition of animal and vegetable matters, which is incessantly proceeding.

A curious and interesting fact, that I happened to discover by these researches on the air, is the want of oxygen during the *siroco* wind, which is so disagreeable to the inhabitants of Sicily. We note in the Table of results two *minima* of oxygen, on March 20 and May 31, and some analyses made at other times, and when also this African wind was blowing, led me to the same conclusion.

March 20, 1879;	siroco wind;	oxygen,	19·994	litres p. c.	
,, 21,	,,	,,	20·008	,,	,,
,, 22,	,,	,,	20·064	,,	,,
April 15,	,,	,,	19·998	,,	,,
May 29,	,,	,,	20·021	,,	,,
,, 30,	,,	,,	20·032	,,	,,
,, 31,	,,	,,	20·017	,,	,,

Here we have seven determinations of the most important element of air during that singular wind with its heat and dryness,* rendering so troublesome the medium in which we are always bathed, and in all cases the want of oxygen is very evident.

I do not know how to explain this curious phenomenon; notwithstanding, I cannot but register it, hoping that the attention of scientific men will be drawn to this unknown condition of the air when the *siroco* wind blows.

Palermo, Italy, January 15, 1880.

* During the siroco wind the relative humidity of air (determined by the psycrometer) is diminished to 30°, 24°, 20°, and even 18°.

ARTIFICIAL PRODUCTION OF THE DIAMOND

The following letter appeared in the *Times* of Feb. 20:—

"*To the Editor of the Times.*

"Sir,—A few weeks since I had to proclaim the failure of one attempt to produce the diamond in a chemical laboratory. To-day I ask a little space in one of your columns in order to announce the entire success of such an attempt by another Glasgow gentleman.

"That gentleman is Mr. J. Ballantine Hannay, of Woodbourne, Helensburgh, and Sword Street, Glasgow, a Fellow of the Chemical Society of London, who has to-day sent me some small crystallised particles presenting exactly the appearance of fragments of a broken diamond.

"In lustre, in a certain lamellar structure on the surfaces of cleavage, in refractive power, they accorded so closely with that mineral that it seemed hardly rash to proclaim them even at first sight to be diamond. And they satisfy the characteristic tests of that substance. Like the diamond, they are nearly inert in polarised light, and their hardness is such that they easily scored deep grooves in a polished surface of sapphire, which the diamond alone can do. I was able to measure the angle between the cleavage faces of one of them, notwithstanding that the image from one face was too incomplete for a very accurate result. But the mean of the angles so measured on the goniometer was 70 deg. 29 min., the correct angle on a crystal of the diamond being 70 deg.

31·7 min. Finally, one of the particles, ignited on a foil of platinum, glowed and gradually disappeared exactly as mineral diamond would do.

"There is no doubt whatever that Mr. Hannay has succeeded in solving this problem and removing from the science of chemistry an opprobrium so long adhering to it; for, whereas the larger part of the great volume recording the triumphs of that science is occupied by the chemistry of carbon, this element has never been crystallised by man till Mr. Hannay achieved the triumph which I have the pleasure of recording to-day, His process for effecting this transmutation, hardly less momentous to the arts than to the possessors of a wealth of jewelry, is on the eve of being announced to the Royal Society.

"I am, Sir, your obedient servant,

"N. STORY-MASKELYNE.

"Mineral Department, British Museum, Feb. 19."

[A detailed paper on the above subject was read at the Royal Society last night, and will appear in the next number of the CHEMICAL NEWS.]

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, February 19, 1880.

Mr. WARREN DE LA RUE, President, in the Chair.

THE list of Officers and Council proposed by the Council for the ensuing year was read from the Chair:—

President—H. E. Roscoe.

Vice-Presidents—F. A. Abel, C.B.; B. C. Brodie; Warren De la Rue; E. Frankland; J. H. Gladstone; A. W. Hofmann; W. Odling; Lyon Playfair; A. W. Williamson; J. Dewar; J. H. Gilbert; N. S. Maskelyne; V. Harcourt; R. Angus Smith; J. Young.

Secretaries—W. H. Perkin, H. E. Armstrong.

Foreign Secretary—Hugo Müller.

Treasurer—W. J. Russell.

Other Members of Council—M. Carteighe, C. Graham, C. W. Heaton, H. McLeod, E. J. Mills, J. M. Thomson, W. C. Roberts, W. A. Tilden, W. Thorp, T. E. Thorpe, J. L. Thudichum, R. Warington.

The following gentlemen were elected Auditors:—A. J. Greenaway, G. H. Makins, and F. J. M. Page; being proposed by Mr. Warington and seconded by Mr. C. J. Neison.

The following certificates were read for the first time:—E. C. Copas, H. H. Slater.

During the evening the following gentlemen were balloted for and declared duly elected Fellows of the Society:—J. C. Evans, W. H. Glazier, J. Hogarth, K. W. Hedges, R. Howell, A. Lloyd, W. Macnab, A. R. Miller, J. McCarthy, G. H. Morris, P. Mathews, W. O. Prosser, H. T. Pasley, W. B. Roberts, G. Salet, A. G. Salamon, T. Terrell, G. Wilcock, W. H. Wood.

During the evening the PRESIDENT mentioned that he has recently seen a crystal prepared by Mr. Hannay, of Glasgow, which had been examined by Mr. Nevil Story Maskelyne, and found to have the angles, lustre, hardness, &c., of the diamond. A similar crystal had been burnt, and found to contain 97 per cent of pure carbon. It was therefore to all intents and purposes a diamond.

The following papers were read:—

"*On the Production of Ozone during the Combustion of Coal-gas*," by R. H. RIDOUT. Some years ago the author possessed a Bunsen burner which always emitted the smell of ozone. By means of an aspirator and suction-tube it was determined that the greatest production took place at the apex of the flame. The burner, however, was injured, and the author has not been able to get the same action again, either with it or with other burners. He noticed subsequently, while working with singing flames, the same smell; in consequence he made several experiments. A glass tube, one-eighth inch bore, conveying coal-gas, was placed inside another tube five-eighth inch bore, 15 inches long. A strip of iodised paper was pasted inside the tube throughout its length: the gas burned with a blue flame. After a short interval the paper was discoloured, and on being moistened gave the oxidising reaction, commencing at a point about half-an-inch above the flame, and decreasing towards the top. The author endeavoured to apply this method of producing ozone to technical purposes, but without success. From several experiments the author concludes that the sulphur in the coal-gas is eliminated as sulphuric acid under the above circumstances. Various experiments were now made to determine the nature of the body which gave the blue reaction with starch. It was not absorbed by passing it through caustic potash or water, which would remove all oxides of nitrogen, whilst no oxidising action was observed in a chromate of potash solution, indicating the absence of peroxide of hydrogen. The author concludes, therefore, that the substance formed was ozone. Ether and alcohol burned from wicks of capillary glass tubes gave similar results. Ozone was also produced by the flame of a minute glass Herapath blowpipe, as long as the cone was perfect and of a violet colour; but as soon as the inner bright green cone was exposed the production of ozone ceased. The same violet colour attends the formation, whilst a green tint indicates the destruction, of ozone in the electric discharge.

Mr. WARINGTON rather doubted whether all the oxides of nitrogen would be retained in the absorbing apparatus described.

Dr. ARMSTRONG mentioned that this production of ozone by gas-flames under certain conditions had been patented some time since.

Mr. RILEY had noticed the smell of ozone round the tuyères of blast-furnaces which were not working properly.

Mr. KINGZETT insisted on the great difficulty in removing traces of ozone from a comparatively large quantity of air. A very long tube and a current of low velocity were essential. He did not think that the experiments just related proved the formation of ozone.

Dr. WRIGHT confirmed the statements made by Messrs. Warington and Kingzett. Carbonic acid would pass through caustic potash, and hydrochloric acid through silver nitrate solution, unless special precautions were taken.

The PRESIDENT said that he had used a washing-vessel with spiral divisions with great success, a large amount (20 to 30 feet) of washing surface being thus obtained in a moderate compass.

The author having briefly replied,

Dr. RUSSELL took the chair, and called on Prof. MCLEOD to make some remarks on the production of ozone by the passage of moist air over phosphorus.

At the last meeting Mr. Kingzett pointed out an error in some calculations which the author had recently brought before the Society. The correctness of this criticism the author frankly admitted, but did not think that the necessary alteration in the results invalidated his arguments (*Journ. Chem. Soc.*, Feb., 1880) as to the formation of ozone during the slow oxidation of phosphorus. In his opinion the evidence was quite conclusive without the quantitative experiments. He had investigated the reaction simply to satisfy himself as to its nature, and at the commencement thought that hydroxyl was probably formed; but the results of about 100 experiments had convinced him that the substance formed was ozone. He had not observed any evidence of the formation of hydroxyl. Thus, phosphorus was placed in a cylinder with sulphuric acid and bichromate of potash. After some time the liquid and the phosphorus were removed, and the gas shaken up with water. The liquid did not affect potassium iodide and starch, whilst the gas instantly turned the mixture blue. He was glad to hear that Mr. Kingzett was continuing his researches on the subject, and would be

pleased to learn that the substance was peroxide of hydrogen, and still more gratified if it turned out to be ozone.

Mr. KINGZETT, in reply, said he believed Andrews had shown that the active substance in air, in which phosphorus had been allowed to oxidise slowly, was removed by prolonged agitation with water, and that a French chemist had recently observed that the water gave the reactions of ozone, but went on to show that this reaction was due to phosphorous acid. He did not think that the presence of ozone had been thoroughly established.

Mr. R. H. RIDOUT then gave an account of "*Some New and Improved Laboratory Appliances*," which were exhibited. A test-tube brush, a piece of red or black india-rubber tubing about 3 inches long and ¼-inch bore has seven longitudinal and parallel slits made to within ¼-inch of each end. One end is then inverted and turned back until it is over the other end: the tube is finally secured to a wooden handle with twine. A blowpipe for spirit-lamp or gas. A hydrogen sulphide apparatus. Two Winchester quarts are fitted up like wash-bottles, the long tubes being connected together by a short piece of india-rubber tubing. The short tube of one bottle is open, the other has a piece of india-rubber tubing and a pinchcock: this tube is connected with a sulphuretted hydrogen apparatus, and the pinchcock opened. The gas drives the oil, with which the Winchester quart is filled, over into the other bottle, which is empty. When the first bottle is filled with SH_2 the apparatus is ready for use. The liquid to be treated is placed in a flask having an india-rubber cork and tube; when the liquid is boiling the latter is connected with the above apparatus, and the steam allowed to condense: the S_2H is rapidly absorbed by the liquid. The liquid is again boiled, to drive back the superfluous gas into the bottle: no smell is perceptible during the operation. Filter Funnel.—The author has had funnels made with stem 0·5 m.m. inside, and sides ground to an angle of 60°; no platinum cone is necessary. He has also contrived an apparatus for delivering the liquid and precipitate into the centre of the filter-paper. Continuous Aspirator.—This consisted of a piece of three-eighths lead tubing bent into a circle, with a hole one-tenth of an inch in the centre of the concave part of the bend. A suction-tube is soldered into this hole: as the velocity of a current of water passing round the bend is greatest on the outside, a relative vacuum is caused on the inside. Filter Pump.—A vacuum is obtained by filling a flask with steam and condensing it. Apparatus for Taking the Gravity of Liquid in Terms of Water at the Same or Other Temperature.—Two graduated U-tubes are connected by a T-tube provided with a pinchcock. The liquids are placed one in each U-tube; air is then blown in by the T-tube, and the pinchcock closed. The liquids are displaced inversely as their gravities. One U-tube, B, is kept filled with pure distilled water; consequently,—

$$\frac{\text{Displacement in B}}{\text{Displacement in A}} = \text{sp. gr. of A.}$$

Messrs. Woolley, of Manchester, make the filter-funnel; Messrs. Townson and Mercer supply the other apparatus.

Dr. ARMSTRONG then made some remarks on "*Some Recent Researches on the so-called Unsaturated Compounds*." Results recently obtained by several perfectly independent investigators have thrown doubt on the theory usually held as to the constitution of the above substances, and re-open the question of the presence of dyad carbon in these compounds. Menschutkin has pointed out (*Berl. Ber.*, xiii., 163), from his experiments on the etherification of hydro-sorbic and sorbic acids, that the former is a primary and the latter a tertiary acid, *i.e.*, that the former contains the group CH_2COOH, and the latter the group C.COOH. Fittig has shown that hydro-sorbic acid is either $C_3H_7CH=CHCOOH$ or $CH_3CH=CHCH_2CH_2COOH$, the latter appearing to be the more probable. Menschutkin's observations would seem to point in the same direction. But rom an acid having this formula it is not possible to derive an acid containing the group C.COOH, unless it be assumed that two atoms of hydrogen are withdrawn from the carbon atom with which the COOH group is associated, and consequently that sorbic acid contains a dyad carbon atom. Reference was then made to Fittig's suggestion of the formula $CH_3CH(COOH).C.COOH$, for either citra or mesaconic acid. The determination of the rate of etherification of the three pyrocitric acids by Menschutkin's method would seem to promise interesting results, although as it is to be expected that the phenomena will be complicated by the occurrence of isomeric change, the method is not so likely to furnish any very conclusive evidence in this case. Lastly, Dr. Armstrong drew attention to the recent important paper by Brühl (*Liebig's Annalen*, 200), and especially to the remarkable conclusions arrived at by him with reference to bodies of the acetylene type.

After a few remarks by Mr. WILLIAMS and Dr. WRIGHT, the Society adjourned to March 4, when a lecture will be delivered by Prof. T. E. Thorpe, "On the Relation between the Molecular Weight of a Body and its Specific Gravity when in the Liquid State.

METEOROLOGICAL SOCIETY.

Wednesday, February 18, 1880.

Mr. G. J. SYMONS, F.R.S., President in the Chair.

DR. J. S. CAMERON, Dr. F. E. Carey, J. B. Charlesworth, A. Collenette, S. Forrest, J. G. Gamble, H. J. Marten, J. Nixon, B.A., W. P. Propert, LL.D., S. Rostron, W. P. Swainson, and E. W. Wallis were elected Fellows.

The papers read were:—

"*On Typhoons in China*, 1877 *and* 1878," by Lieut A. CARPENTER, R.N.

"*Note on the Reports of Wind Force and Velocity during the Tay Bridge Storm, December* 28, 1879," by R. H. SCOTT, F.R.S. These reports seemed to show that the velocity of the wind on that occasion was not so high as was generally supposed, and had been frequently exceeded, but that some of the gusts were very violent.

"*On the Frost of December*, 1879, *over the British Isles*," by W. MARRIOTT, F.M.S. Exceptionally low temperatures were registered all over the British Isles from the 1st to the 7th of December. On the 1st, the lowest temperature was −2° at Ketton, near Stamford; and the next lowest was 5° at Trent College. The temperature continued low throughout the day, at several places not rising above the freezing-point. On the 2nd the cold was more intense. In the counties of Leicester, Lincoln, and Nottingham, the temperature fell below zero, the lowest being −4·5°, at Coston, near Melton Mowbray. Temperatures between 0° and 10° were registered in the north and south of Scotland, and along the central part of the north of England to the Midland and Eastern counties; while over the whole of England, Scotland, and Ireland, with the exception of the sea-coast stations, the temperature fell below 20°. On the 3rd the temperature was more evenly distributed, and not quite so intense as on the previous day. However, in the North Riding of Yorkshire and the Valley of the Tees, readings at and below zero were registered, the lowest being −2° at Gainford. On the 4th intensely cold weather was experienced over the south of Scotland and the north of England, the lowest reading obtained was −23°, at Blackadder, in Berwickshire. −16° was also registered at Springwood Park, near Kelso, and readings of −5° were reported at Haddington, Melrose, and Corbridge-on-Tyne, and −4° at Alston. Temperatures below 10° were registered over the south and south-east of Scotland, and over the north of England as far as the Valley of the Trent, and also in the Eastern Counties; while over almost the whole of England, Scotland, and Ireland the temperature fell below 20°. In some parts of the south of Scotland and the Border counties the maximum temperature during the day did not rise to 20°. On the 5th the minimum temperature was not so low as on

he previous day, there being a cloudy sky and a general fall of snow. In Ireland, however, this was the coldest day of the month. On the 6th the temperature fell considerably in Derbyshire, Nottinghamshire, and Yorkshire: readings of 3° being recorded at Trent, −1·0° at Buxton, and 0° at York and Stanley. At many places the maximum temperature during the day was much below the freezing-point. On the 7th very low temperatures were registered over the whole of the north and east of England; the lowest reported was −10° at Ketton, near Stamford. The temperature fell below zero in the counties of Essex, Leicester, Derby, Lincoln, Nottingham, and York, and also in the south of Scotland, while over almost the whole of the north-east and central part of England, as well as a portion of the south-east district, the temperature fell to 10° or below. Readings below 20° prevailed over nearly the whole of England and Scotland and the centre of Ireland. The maximum temperature during the day at a few places was extremely low, the thermometer at Appleby only recording 12·4°, and that at York 18°. During the next few days a little warmer weather prevailed, but on the 9th the temperature fell below 20° over the central part of England, Scotland, and Ireland. Low temperatures were also experienced at most places on the 12th. Milder weather continued for the next few days, but on the 17th the temperature again fell below 20° over the whole of the south of England. Low temperatures also prevailed on the 18th, 21st, 23rd, 24th, and 26th, while the maximum temperatures at many places on the 21st and 26th did not reach 32°. At almost all the inland stations frost occurred on an average of about 25 days during the month, and temperatures below 20° were registered from 8 to 13 days at several places. The only station where frost was not felt was Scilly, the lowest temperature recorded there being 33° on the 2nd. The only comparatively mild districts were the west and south of Ireland and the extreme south-west of England. Even the seaside health resorts which are reputed for their mild climates were not exempt from the cold, the temperature falling below the freezing-point on eleven occasions at Ventnor, fifteeen at Torquay, twenty at Sidmouth and Eastbourne, and twenty-four at Ramsgate and Worthing. During the time of the cold weather the barometer was very high over these islands, and an anticyclone was formed over those districts where the lowest temperatures were recorded. That the cold was the result chiefly of radiation is shown by the great difference in temperature at the hill and valley stations. For instance, at Farley, 640 feet above sea-level, 17·7° was registered on the 7th, while at Oakamoor, 300 feet lower, in the Valley of the Churnet, and less than a mile distant from Farley, the temperature fell to 1·1°. The effect of the cold upon the health of the community way very great. In London, the number of deaths referred to diseases of the respiratory organs increased to 799 in the week ending December 20th, and exceeded the week average by 228. The public journals record the fact that several persons were frozen to death in various parts of the country. The frost also caused great injury to plants, shrubs, and birds.

CORRESPONDENCE.

ALCOHOL TABLES.

To the Editor of the Chemical News.

Sir,—Mr. Cohné (Chemical News, vol. xli., p. 57) maintains the superiority of his formula for alcohol calculations, asserts that mine are erroneous, and states that proof-spirit contains 49·5 per cent by weight of absolute alcohol. All three of these positions are in error, as I propose to show.

Mr. Cohné quotes from an unmentioned author that "proof-spirit has a gravity of 0·9186 at 60° F., and contains 57·27 per cent by volume, or 49·5 by weight of absolute alcohol." Mr. Cohné does not mention his authority for this statement, which I find occurs in "Muspratt's Chemistry" (volume i., page 132) being reproduced *verbatim* in the new publication edited by Charles Vincent. As I stated before, I have no intention of discussing with Mr. Cohné the reason of the difference in the strength of proof-spirit as taken by him from that adopted by most chemists, but I can assure him, if he will enquire into the matter, that he will find proof-spirit at 60° F. has a density of 0·91984, and contains 49·24 per cent of absolute alcohol by weight, or 57·06 per cent by measure. If he does not care to work out the calculation for himself, he will find on reference to the "authorities" that this is the recognised strength of proof-spirit.

Mr. Cohné asserts that my formulæ give results which are incorrect. He takes the example, 95·1 per cent of alcohol by volume, what percentage of proof-spirit? Mr. Cohné works this out by my formula to 166·6 per cent of proof-spirit, and says this result "is wrong!" And yet Mr. Cohné works out the very same example (page 58), and obtains 66·1 over proof, or a difference of 0·5, due to the fundamental discrepancy in our definition of proof-spirit! Is it possible that Mr. Cohné has stumbled over the tyro's paradox that strong alcohol contains more than 100 per cent of proof-spirit? His statement that the result 166·6 "is wrong" certainly suggests that notion. What percentage of proof-spirit does Mr. Cohné make out corresponds to absolute alcohol.

Mr. Cohné writes—"How much is 20 percentage of proof, percentage by volume? By his (Allen's) formula $V = P \times 0{\cdot}5706$ would give 11·46, which figure is, I suppose, intended to be deducted from the factor 57·06 = 45·6, which in this case brings it to my (Cohné's) formula."

If Mr. Cohné maintains that 20 per cent of proof-spirit corresponds to over 45 per cent of alcohol by measure. I suppose he will next assert that 1 ton of coals may contain 45 cwts. of carbon! 11·46 per cent of alcohol by measure is the true answer, and there is no deduction from the factor either expressed or intended. It really appears that Mr. Cohné supposes the terms "20 per cent of proof-spirit" and "20 per cent under proof" to be synonymous. On page 58, Mr. Cohné works out 20 under proof to equal 45·55 of alcohol by measure, so that, according to him, spirits of 80 under proof and of 20 under proof are equally strong in alcohol.

I work out this last example by Mr. Cohné's formula and by mine that your readers may judge for themselves which is the simpler plan:—

Cohné.—$57{\cdot}27 - (20 \times 0{\cdot}5727) = 45{\cdot}55$.
Allen.—$80 \times 0{\cdot}5706 = 45{\cdot}648$.

In the second case it is unnecessary to write down a single figure besides those shown. By Mr. Cohné's method it is impossible for an ordinary person to work out the answer without writing down the product of $20 \times 0{\cdot}5727$ under 57·27. To quote Mr. Cohné—"It needs not the ability of a Cambridge Wrangler to decide which formula is the more concise." Neither his nor mine have much claim to originality.—I am, &c.,

Alfred H. Allen.

Sheffield, Feb. 16, 1880.

THE CHEMICAL SOCIETY.

To the Editor of the Chemical News.

Sir,—The following grants have been made by the Council of the Chemical Society from their Research Fund:—

£100 to Dr. C. R. A. Wright, for determinations of chemical affinities in terms of electrical magnitudes.

£100 to F. D. Brown, for experiments on vapour-tensions.

—I am, &c.,

W. J. Russell.

Chemical Laboratory,
St. Bartholomew's Hospital, E.C.,
Feb. 24, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 5, February 2, 1880.

Experiments on the Compression of Gaseous Mixtures.—L. Cailletet.—From the author's experiments it appears probable that under high pressures a gas and a liquid may mutually dissolve each other, so as to form a homogeneous whole.

Remarks on the New Metals from Gadolinite and Samarskite.—M. M. Delafontaine.—See p. 72.

Artificial Reproduction of Skorodite.—MM. Verneuil and Bourgeois.—This mineral is produced by treating iron at 140° to 150° in a sealed tube with a concentrated solution of arsenic acid.

Gazzetta Chimica Italiana. Anno 9, Fasc. 10, 1879.

Researches on Cobalt and Nickel, and on the Methods of Distinguishing them from Each Other.—G. Papasogli.—(See p. 74.)

Constitution of Ellagic Acid.—Ugo Schiff.—A hypothetical paper, not susceptible of useful abstraction.

Determination of Acetyl by means of Magnesia.—Ugo Schiff.—In the first place it is important to have a pure magnesia. Neither the *magnesia usta* nor the *magnesia alba* of commerce give good results, because they contain alkaline carbonates which are not removed without difficulty. It is necessary to make use of magnesia precipitated from the pure sulphate or chloride by caustic alkali, avoiding excess. After long and careful washing, the magnesia thus obtained is preserved in the form of a moist paste. In a flask of hard green glass are mixed about 5 grms. of this paste with 1 to 1·5 grms. of the acetylic derivative finely pulverised. A uniform paste is made with the addition of a little water, and after adding 80 to 100 c.c. more water it is heated for four to six hours. In many cases the decomposition is complete in two or three hours. The contents of the flask are then evaporated down to a third, and when cold are filtered through an aspiration filter into a conical test-glass. The residue is washed with a little water, mixed with ammonia and sal-ammoniac, and precipitated with a strongly ammoniacal solution of ammonium phosphate. The vessel is left in a warm place over night, the mixture filtered, the precipitate re-dissolved in dilute hydrochloric acid, and the operation repeated.

Action of Ozone on Certain Noble Metals.—Prof. Aless. Volta.

On Para-oxymethyl-phenyl-cinnamic Acid, and on Oxymethyl-stilben.—Dr. A. Oglialoro.—An account of the properties and composition of these compounds.

Action of Perchloride of Phosphorus on Molybdic Anhydride.—Arnaldo Piutti.—These substances react according to the equation—

$$2MoO_3 + 6PCl_5 = 2MoCl_5POCl_3 + 4POCl_3 + Cl_2.$$

On Certain Derivatives of the Naphthols.—C. Marchetti.—A description of monobro-methylic α-naphtholate, of methylic α-naphtholate, and of methylic β-naphtholate.

Distribution of Copper in the Animal Kingdom.—Dr. Michele Giunte.—The author has detected copper in many animal species belonging to widely distinct groups.

On the Amins corresponding to α-Toluolic Alcohol.—Dr. P. Spica.—An extensive paper, not suitable for abstraction.

Preparation of Hydroxylamin.—Dr. Giacomo Bertoni.

Transformation of Hydroxylamin into Nitrous and Nitric Acids.—Dr. Giacomo Bertoni.—For these two papers also the reader is referred to the original.

An Easy and Rapid Process for Detecting at once Nitrogen, Sulphur, and Chlorine in Organic Bodies.—Dr. P. Spica.—Into a small tube, of about 5 m.m. diameter, is put a small quantity of the substance under examination along with a globule of sodium or potassium. It is heated strongly, and when the tube is red-hot the contents are thrown into a small beaker containing a few grammes of pure water. The liquid is heated, filtered, and divided into three portions. If a drop, placed upon a slip of polished silver, produces a black spot, sulphur is present. Another portion of the liquid is treated with a mixture of ferric and ferrous salt, and then with a few drops of dilute hydrochloric acid, to dissolve the ferric hydrate. A blue colouration or precipitate indicates the presence of nitrogen. The remaining portion of the liquid is treated with dilute nitric acid, and then with silver nitrate, if the results of the former tests have been negative, in order to detect chlorine (bromine or iodine). If one or both of the former tests have given positive results the liquid is heated for two minutes with its own volume of pure concentrated sulphuric acid, in order to decompose alkaline sulphide and cyanide, and silver nitrate is finally added.

Correspondenz-blatt des Vereines Analytischer Chemiker. No. 1, January, 1880.

Analysis of Phosphates containing Silica and Fluorine.—H. Gilbert.—In the determination of silica in fluoriferous phosphates, especially apatite and phosphorite, losses are often experienced when the separation of silica is effected by digesting or evaporating the sample with concentrated hydrochloric or nitric acid, as considerable quantities of silicofluoric gas are volatilised. This loss is avoided or brought to a minimum if the calcium phosphate and fluoride is dissolved by gently heating in strongly diluted hydrochloric acid, the solution separated from silica by decantation, and the latter substance afterwards perfectly freed from ferric oxide by digestion in concentrated hydrochloric acid. The author in the analyses here quoted digests 2 grms. of powdered apatite in a platinum capsule, with 50 c.c. of dilute hydrochloric acid (1 part acid at sp. gr. 1·12 with 10 parts of water), for ten minutes on the water-bath, decants the solution through a filter, treats the residue once more in the same manner, and finally dissolves the last traces of iron by heating with concentrated hydrochloric acid, collecting the silica upon the filter which has been already used. The fluorine present in phosphorite was calculated from the lime, and was as a check determined by Penfield's method. For this purpose 5 grms. of finely-ground phosphorite was mixed in a platinum crucible with 10 grms. of powdered quartz, the mixture ignited, placed in the apparatus along with 50 c.c. of concentrated sulphuric acid and distilled. The alcoholic solution of potassium chloride was placed not in a U-tube, but in a Bunsen's washing bottle containing a little mercury, into which the delivery tube dipped. A second washing bottle, containing a similar solution, was connected as a matter of precaution, but the decomposition was completely effected in the first. The liberated silica was equally diffused in the liquid.

Analysis of Children's Foods.—N. Gerber and P. Radenhausen.—(The term "kinder-mehl" is applied to mixtures of condensed milk with the prepared flour of cereals.) The authors determine moisture by drying at 100° to 110° C. for five to six hours in a platinum capsule. The residue is afterwards incinerated at low redness, and in the weighed ash the phosphoric acid is determined by means of uranium. For fatty matter 2 or 3 grms. of the sample are placed in a filter, dried in an air-bath at 50° to

60°, allowed to cool, and extracted in Gerber's apparatus. The necessary quantity of ether is preferably poured not direct into the flask, but upon the dried sample. The extraction is complete in one to two hours. The ethereal solution is allowed to evaporate, dried at 100° to 110°, and the residue (fat) is weighed. The meal remaining on the filter serves for the determination of soluble and insoluble carbohydrates. The authors extract the residue from the last process with 250 c.c. of alcohol of 50 per cent with frequent agitation. This operation is performed in a flask, and requires about ten hours. The liquid is then filtered by means of a filter-pump, washed with alcohol of the same strength, and the whole is made up to 500 c.c. Of this, 100 c.c. is evaporated down in a tared platinum capsule. The residue, deducting the ash, when multiplied by 5, gives the soluble carbohydrates in the quantity of the sample operated upon. The residue on the filter is introduced, still moist, into a flask containing 400 c c., covered with 200 c.c. water and 20 c.c. hydrochloric acid, and heated for three hours in boiling water, closing the flask with a cork. The inversion is then completed, and the whole is filtered through a folded filter. The filtrate is neutralised with alkali, and made up to 1000 c.c. If, on standing, albuminates, which have been again rendered insoluble by the neutralisation, should be deposited, which is generally the case, an aliquot part of the solution is filtered through an unwetted filter into a dry beaker. The solution contains the grape-sugar generated from the starch, and is titrated with Fehling's solution. In calculating the result, the authors assume 108 grape-sugar = 99 starch. The albuminates are determined as difference.

Analysis of Women's Milk.—N. Gerber and P. Radenhausen.—5 c.c. of the sample were mixed with 100 c.c. of distilled water, 3 c.c. solution of copper were added and titrated back with 2·5 c.c. potassa solution, the result being a clear liquid and a finely flocculent coagulum. This precipitate is treated as the authors have elsewhere recommended for cows' milk, and the clear filtrate is made up to 250 c.c.

An Extremely Sensitive Reagent for Lime.—This is sodium tungstate, as proposed by Sonstadt. As calcium tungstate is somewhat soluble in sodium tungstate it is necessary where very small quantities of lime are present, *e.g.*, in the analysis of water, to add the reagent drop by drop.

Reimann's Färber Zeitung,
No. 3, 1880.

The German patent for a benzol washing machine has been officially cancelled. The machine had been known and in general use for *ten years* before it was made the subject of a patent. [That a patent could, under such circumstances, be obtained, is a proof of the utter uselessness of those "preliminary examinations" which the German and the American patent laws require, and which certain legal authorities wish to introduce into the English system.]

Verhandlungen des Vereins zur Beforderung des Gewerbfleisses. No. 10, December, 1879.

Corrosion of Metallic Zinc when used as Boiler Protector.—Dr. Kosmann.—Zinc introduced into steam-boilers to prevent incrustation proves very useful in case of selenitic waters, but as against the carbonates of lime, magnesia, and iron it is of little value. The zinc is soon rendered brittle and porous and is in course of time reduced to a powder.

Die Chemische Industrie.
No. 12, December, 1879.

Ammonia and Leblanc Soda.—Dr. Reinhold Hoffmann.—The author shows that the Leblanc process, thanks to the recent improvements, now yields high-class alkali, containing 98 per cent of sodium carbonate. The only distinction worth naming is that the ammonia (Solvay) soda is richer in sodium chloride and insoluble matter, whilst in the Leblanc soda the portion not carbonate consists chiefly of sulphate. Dr. Hoffmann considers that the question between the two processes is essentially one of price, in which the Leblanc system has important allies in the production of hydrochloric acid and in the recovery of sulphur from the tank-waste.

NOTES AND QUERIES.

Purification of Glycerine.—Can any correspondent inform me of the best process for distillation and purification of glycerine, with the names of makers of plant.—J. R. B.

Redonda Phosphates.—Your correspondent "Unprejudiced," in the Chemical News, vol. xli., p. 58, says there are thousands of tons in this country lying idle. Will "Unprejudiced" oblige by stating where half cwt. or so can be had containing there or about 36 per cent P_2O_5. He says this represents 80 per cent calcic phosphate.—Phosphates.

MEETINGS FOR THE WEEK.

Monday, March 1st.—London Institution, 5.
—— Medical, 8.30.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Arts, 8. "The Manufacture of India-rubber and Gutta-percha," by Thomas Bolas, F.C.S.
Tuesday, 2nd.—Royal Institution, 3. Prof. Schäfer, "Physiology of Muscle."
—— Civil Engineers, 8.
—— Zoological, 8.30.
—— Pathological, 8 30.
Wednesday, 3rd.—Society of Arts, 3. Alexander J. Ellis, F.R.S., "The History of Musical Pitch."
Pharmaceutical, 8.
Thursday, 4th.—Royal Institution, 3. Prof. Dewar, "Chemical Progress."
—— London Institution, 7.
—— Chemical, 8. Prof. T. E Thorpe, "On the Relation between the Molecular Weight of a Body and its Specific Gravity when in the Liquid State."
Friday, 5th.—Royal Institution, 8. Mr. H. N. Mosely, "Deep Sea Dredging and Life in the Deep Sea," 9.
Saturday, 6th.—Royal Institution, 3. Mr. Saintsbury, "Dryden and his Period."

TO CORRESPONDENTS.

W. Robinson.—The following work is a good illustrated text-book of chemistry in German:—"Grundzüge der Chemie in ihrer Anwendung auf das Praktische Leben," by Professor Wilibald Artus. Leipzig: Hartleben.

WATTS'S DICTIONARY OF CHEMISTRY.

Seven Volumes, 8vo., price £10 16s. 6d.

A DICTIONARY OF CHEMISTRY, and the Allied Branches of other Sciences; founded on that of the late Dr. Ure. By Henry Watts, B.A., F.R.S., assisted by eminent Scientific and Practical Chemists.

"The English language is not rich in lexicons of science; we would point to this work as a model upon which others might be framed. To the practical analyst this work must prove of the utmost value—to the philosophical investigator it must, as the record of all former labours, be a great gain—and to the student who is true to his studies it will prove an ever-ready guide. Our manufacturers know the value of chemistry, and are many of them experts in the special branches of the science which bear on their particular industries. They require to know the latest discoveries, and to keep them as it were in stock until the march of improvement renders it necessary to apply them. This "Dictionary" places them in possession of these *desiderata*."—*Athenæum.*

THIRD SUPPLEMENTARY VOLUME (Vol. VIII.), completing the Record of Chemical Discovery to the year 1877. In Two Parts, of which the first is now ready, pp. 844, price 36s., cloth.—Part II. in the Autumn.

"We cannot give this volume greater praise than by saying that it is worthy of the European reputation which Mr. Watts's Dictionary has already acquired as a standard work of reference."—*Bristol Mercury.*

London: LONGMANS and CO.

THE CHEMICAL NEWS.

Vol. XLI. No. 1058.

ON THE SOLUBILITY OF SOLIDS IN GASES.*

By J. B. HANNAY, F.R.S.E., F.C.S., and JAMES HOGARTH, F.C.S.

The research which we now have the honour of submitting to the Royal Society, and of which a preliminary notice was published in the Society's *Proceedings*,† was instituted with the view of throwing some further light upon what Dr. Andrews calls the "critical state" of matter. In his famous Bakerian lecture, after a very careful discussion of the question, Dr. Andrews says:‡—"Carbonic acid at 35·5° C., and under a pressure of 108 atmospheres, stands nearly midway between the gas and the liquid, and we have no valid grounds for assigning it to the one form of matter any more than to the other." This conclusion is based on the relation of volume to pressure for different temperatures, and on the failure of optical tests to show any distinction between gas and liquid when pressure is applied above the critical temperature. It occurred to us that some knowledge might be gained by examining the solvent properties of some fluid for a non-volatile solid, in the passage of the solvent from the liquid to the gaseous state. The property of dissolving solids being supposed peculiar to liquids, it seemed to us that on passing through the critical state there would be a precipitation of solid, or if, on the other hand, no separation occurred, a further proof of the perfect continuity of the gaseous and liquid states would be presented. To put the matter to the test, a solution of potassic iodide in alcohol was prepared, and a strong tube filled to about one-half with the solution. After sealing, the tube was placed in an air-bath, and heat applied. No precipitation of solid could be seen, even at a temperature of 350° C., more than 100° C. above the critical point of alcohol.

For the examination of the phenomena of solution some form of pressure apparatus was necessary, so that the volume of the fluid experimented on might be altered at pleasure. After several experiments we adopted a modified form of Dr. Andrews's apparatus, which allowed us to change an experimental tube in a few minutes, and showed no sign of leakage at the highest pressure reached. It is made of wrought-iron tubing, such as is used in hydraulic machinery, about ½ inch internal, and 1 inch external diameter. The length of the apparatus is 9 ins., and there is a side tube welded on, measuring about 3 ins., for the insertion of the manometer tube. On the ends of the tube are screwed strong caps, also of wrought-iron; through one of these the pressure screw works, the others serve for the admission of the experimental and manometer tubes. The distinguishing feature of the apparatus is the packing for the screw and tubes. It consists of a solid plug of india-rubber, about ½ inch thick, placed in the hollow cap, so that it serves both for packing the screw or tube, and for making the joint between the cap and the iron tube tight. To prevent the pressure screw from cutting the india-rubber, a lining of thin leather, well soaked in lard, was placed between it and the rubber. The tubes were similarly packed, and to keep them from being forced out through the aperture in the cap a thickening was made in the glass by fusing and pressing together, and between this bulbous part and the iron a strong leather washer was placed. In some cases, when a very high pressure was wanted, the tube was cemented in with oxychloride of zinc, which effectually prevented it from coming in contact with the iron cap. With this mode of packing the pressure screw did not require to be very fine, the one commonly used being ¼ inch in diameter and screwed 30 threads to the inch. The only limit to the pressure was the frailty of the glass tubes: we have, however, attained a pressure of 880 atmospheres as shown by an air manometer, and even at this enormous pressure the screw could be freely removed in either direction without leakage. The apparatus was as tight with mercury as with water, so that there was no necessity for using two liquids as in Dr. Andrews's machine. When a high temperature was required the experimental tube was bent over, as shown in the drawing, and passed into an air-bath formed of two concentric iron cylinders. The cylinders had mica windows, through which the experiment could be observed, and to ensure perfect regularity of temperature the inner one was lined with cement about ½ inch thick. As in most of our experiments it was quite unnecessary to know the pressure; a simple straight tube was used instead of the T-shaped one described. It was screwed to fit the same caps, and from its simplicity made a very convenient and efficient apparatus.

The experiments with the sealed tube showed us that no deposit of solid occurred above the critical point. With the assistance of the apparatus just described we were able to show a crystal of potassic iodide dissolving in alcohol gas (using the word gas, as Dr. Andrews proposes, for a fluid at any temperature above its critical point). Having fixed a tube (internal diameter 0·75 m.m., external 7 m.m.) in the apparatus previously filled with mercury, some alcohol was sucked in by gradually withdrawing the pressure screw. By a further withdrawal of the screw the little thread of alcohol was moved inwards past a constriction made in the glass tube near the end, and a small fragment of fused potassic iodide dropped in so as to rest on the narrow neck. Sufficient heat was now applied to boil the alcohol and expel the air, and the end of the tube strongly sealed with the blowpipe. The tube being placed in its position in the bath, heat was applied, and the pressure regulated so as to keep the alcohol from passing round the bend into the other limb of the U-tube. The tube and its contents were thus raised to a temperature of 300° C. (the critical point of alcohol, as will be shown, is 234·4° C.), the crystal never having come in contact with the liquid alcohol. Pressure was now applied until the alcohol was reduced to about the volume occupied by it while still liquid, when the fragment of iodide was seen to dissolve gradually and completely. On withdrawing the screw slowly no deposit occurred even when the volume was very considerably increased, but by taking off the pressure very rapidly a crystalline film appeared on the glass, and in some cases a cloud of fine crystals floating in the menstruum. These crystals could be easily re-dissolved by again increasing the pressure. The deposit most frequently occurred just at the surface of the mercury, and this we ascribe to a local rarefaction caused by the slightly higher temperature of the mercury. The fact of the existence of solvent power above the critical point being established by this experiment, we next sought to examine the phenomenon by using other solvents and solids. The sealed tube method was found most convenient for this purpose, an experiment with the pressure apparatus being resorted to when we wished to vary the volume. The tube was filled from half to two-thirds with the solution to be tested, and by a few experiments with the strength of the solution was so adjusted that no separation of solid took place, when the tube was completely filled by expansion.

The behaviour of a solution of potassic iodide we have already described. Bromide of potassium gave a similar result. The solubility of chloride of calcium in alcohol was found to be uninterrupted by the passage of the alcohol through the critical state. Cobaltous chloride (anhydrous) remained in solution at 320° C., the high temperature reached in this experiment, and the bear

* Extracts from a Paper read before the Royal Society, February 26th, 1880.

† *Proc. Roy. Soc.*, vol. xxix., p. 324.

‡ *Phil. Trans.*, 1869, p. 588.

blue colour of the solution was unimpaired. Ferric chloride (sublimed) gave a yellow fluid at a temperature of 260° C. This yellow colour rapidly disappeared, and a reddish-coloured powder separated out, which remained insoluble on cooling. On opening the tube a strong ethereal odour was perceived. This was most probably due to the formation of ethylic chloride. Some peculiar phenomena observed when heating the ferric chloride solution deserve description. At a temperature of 120° C. a very strongly coloured liquid layer appeared at the bottom of the tube, while the uppermost layer was perceptibly paler. As the temperature rose the two layers gradually mixed, and the fluid was quite homogeneous at and above the critical point.

A solution of ferric chloride in ether was distinctly coloured at least 30° C. above the critical point, but the colour gradually faded, and did not return on cooling. The separation and re-dissolving of part of the ferric chloride occurred also with ether.

A solution of sulphur in carbon disulphide showed no separation of sulphur when raised 50° C. above its critical point. Of course sulphur at this temperature is a liquid, but its vapour tension is comparatively so small that its solution is worth recording. Selenium also remained in solution in carbon disulphide above its critical point, and separated out in part when the solution cooled. Chemical action evidently took place in this experiment, for on evaporating a portion of the solution after heating a reddish yellow residue containing selenium was obtained. The liquid had a distinct horse-radish smell, and on burning gave a dark stain on a piece of porcelain held in the flame. Sulphide of selenium was most probably formed. An attempt was made to dissolve cadmic sulphide in carbon disulphide, but without success. In an experiment with metallic arsenic and carbon disulphide the arsenic seemed to dissolve ; but as an orange-coloured film appeared on the glass on cooling, we are inclined to doubt its solubility. When some sulphur was enclosed in the tube with arsenic and carbon disulphide, and the temperature raised above the critical point, solution occurred, and when the temperature was allowed to fall a separation of dense liquid drops took place at the critical point. At a lower temperature these solidify and form reddish yellow crystals. The apparent solubility of arsenic was thus probably due to its conversion into a sulphide, and the subsequent solution of the sulphide formed.

Carbon tetrachloride was also tried as a solvent ; but as the number of substances soluble in this fluid is very small, we can only record a few negative experiments. Cupric chloride did not dissolve, but appeared to be acted on chemically above the critical point, its colour changing to brown. Chromic chloride showed no sign of solution. Zinc oxide did not dissolve, but at a temperature 20° or 30° above the critical point a sudden chemical change occurred. and as a result the critical point was found to be lowered from 280° C. to about 200°. On cooling some transparent globules were seen, and on opening the tube there was an outrush of gas. The transparent globules dissolved in water, and were found to be chloride of zinc.

The use of water as a solvent was quite out of the question, both on account of its high critical point and the corrosion of the glass tubes, so that we were debarred from the use of the liquid whose examination promised most.

The mixture of light paraffins known as paraffin spirit was tried as a solvent for some organic substances. A solution of resin in this liquid remained perfectly bright and without sign of separation at a temperature of 350° to 360°, almost 100° above the critical point.

The examination of liquids to determine their critical temperature and pressure was not exactly in the line of our research ; but as Cagniard de la Tour's numbers, so far as we are aware, are the only ones on record, we have made a number of experiments in this direction. To obtain accurate measurements of pressure is a matter of great difficulty, and as for our purpose these were not required, it would have made our research unnecessarily tedious to attempt it. Our numbers are as follows :—

	Alcohol.	Carbon Disulphide.	Carbon Tetrachloride.
Mean temperature ..	234·6°	272·96°	277·9°
Number of experiments	47	12	4
Probable error of a single experiment ..	2·06°	1·34°	0·69°
Mean pressure	65 atmos.	77·9 atmos.	58·1 atmos.
Number of experiments	14	12	4
Probable error of a single experiment ..	1·0 atmos.	1·5 atmos.	0·55 atmos.

The alcohol used had a specific gravity of 0·7949 at 15·5° C. In the carbon tetrachloride experiments the mercury was attacked, but our numbers were taken as quickly as possible, and before chemical action had taken place to any great extent.

Cagniard de la Tour gives the following results for alcohol and carbon disulphide :—

Alcohol	158·7° C.	119·0 atmospheres.
Carbon disulphide	275·0° C.	77·8 ,,

The differences between Cagniard de la Tour's numbers and our own in the case of alcohol are no doubt due to the difficulty of obtaining that body anhydrous. As will be seen from the density given, the alcohol used in these experiments contained only a very small quantity of water, and was indeed practically anhydrous.

To determine whether the presence of a solid in solution affected the critical temperature and pressure, a cold saturated solution of potassic iodide in alcohol was prepared. Experiments with this solution gave as the average of three trials—temperature 237·1° C., pressure 71·1 atmospheres. The probable error of a single experiment is for the temperature 0·37 C., for the pressure 0·5 atmosphere. The exact amount of solid present in solution when the readings were made it was impossible to determine ; for in altering the volume, so as to observe the critical point, a small quantity was deposited on the glass just at the end of the mercury column. To make sure that some salt did remain in solution we brought the mercury column up so as to cover the crystalline film, and, after carefully examining to see that no solid particles were above the mercury, we allowed the fluid to cool under pressure. When cold the end of the capillary was broken off, and the liquid, which had been shut off by the mercury from contact with the crystalline deposit, received in a watch-glass. On evaporation it gave an appreciable residue. These experiments seem to show that a liquid has its critical point raised by the solution in it of a solid.

As the solubility of potassic iodide in alcohol is very slight (1 part in 40 at 13·5° C.) we thought it advisable to try a solution of chloride of calcium in alcohol, so that the effect of solution on the pressure and temperature might be shown in a more marked degree. On heating a cold saturated solution of calcic chloride (anhydrous), a dense liquid layer was observed to form at the bottom when the temperature reached 230° C. ; at 240° C. the line separating the lighter layer of liquid from vapour was very indistinct, and could not be distinguished at all above 250° C. ; at 255° C. the dense layer dissolved, but reappeared when pressure was taken off. When the volume was again reduced it re-dissolved, and at 270° C. expansion caused a deposition of crystals. In this experiment there was no sharp critical point, and no pressure readings were taken. A dense layer, it will be remembered, was also noticed in the ferric chloride experiment. A combination of the chloride with part of the alcohol evidently occurs, and at a higher temperature diffusion takes place until the fluid is quite homogeneous.

While working with cobaltous chloride an interesting question presented itself to us—Is the absorption spectrum of a substance dissolved in a fluid above its critical point the same as in liquid solution or in the solid state? To

Ammann

answer this question a solution of anhydrous cobaltous chloride was sealed in a tube as before, and its spectrum observed while heat was applied. No change could be detected in its passage through the critical point, and a careful comparison of the spectra of the same solution at 15° C. and at 300° C. showed no difference beyond the fainter and more nebulous character of the bands caused by expansion. The position of the bands was not changed. Chloride of cobalt, however, was not well fitted for our purpose, the measurement of the bands being rather uncertain on account of the nebulous nature of their edges. At the suggestion of Prof. Stokes, we turned our attention to the product of the decomposition of chlorophyll by acids. The beautiful spectrum of a solution of this body in alcohol was quite permanent, even at a temperature of 350° C., although when heated in air it decomposes below 200° C. A direct comparison of the hot and cold solutions failed to show any change in the position of the lines.

A good opportunity of testing the question further seemed to be offered by the blue solution of sodium in liquefied ammonia, described by Gore.* To prepare this we first tried compression of the gas by the pressure apparatus, but the quantity of liquid got by this method was too small for experiment. We next tried a combination of Gore's method with the pressure apparatus. A tube, shaped as in the drawing, had the wide part charged with chloride of calcium saturated with ammonia, and the end sealed. By applying slight heat the air was expelled by the liberated ammonia. A small piece of sodium was then placed in a pocket near the end of the experimental tube, and, after sealing, the tube was placed in the pressure apparatus and surrounded with mercury. The iron tube was now heated by flaming with a Bunsen, and the experimental tube cooled in a freezing mixture. Distillation of ammonia commenced, and when a sufficient quantity of liquid was obtained the pressure screw was advanced, until, coming in contact with the wide tube, it broke the narrow neck joining it with the experimental tube, and allowed the mercury to rush in and enclose the liquefied ammonia. Further pressure brought the ammonia in contact with the sodium and solution commenced, but an unforeseen difficulty caused the experiment to fail, for the sodium solution coming in contact with the mercury was rapidly decolourised by it. It was therefore necessary to dispense with the use of mercury. Several methods were proposed, and we finally arrived at the following simple and effective one:—A piece of tubing, about ¼ inch diameter, was joined to a piece of marine barometer tubing, and just beside the join the latter was drawn out to an exceedingly fine bore. The wide tube was now charged with ammonia-saturated chloride of calcium, and the end sealed. A small piece of solid paraffin was then dropped into the capillary tube so that it lay next the drawn-out portion. When all air was expelled by heating slightly, a few fragments of sodium were placed in the tube, and the whole sealed. The end containing the sodium being placed in a freezing mixture, the wide tube was carefully heated until sufficient ammonia was distilled over. When re-absorption commenced the fragment of paraffin was melted by the application of a very small flame, and capillary attraction caused it to run into the fine bore, where it solidified and prevented any passage of ammonia. The tube now containing a solution of sodium in ammonia was next cut off near the join, and the end sealed in the blowpipe flame, the paraffin plug preventing outward pressure. On heating the tube thus prepared in the air-bath, the blue colour disappeared before the critical point was reached, and the loss of colour was accompanied by the deposit of a white powder. It was at first thought that this was due to the presence of water in the ammonia, but many experiments, in which every care was taken to have the ammonia perfectly dry, failed to give any other result. In one case only, when the temperature had been raised very rapidly, did the blue colour remain above the critical point, and this only for a few seconds. This chemical action most probably consists in the formation of sodamide, and this view is supported by the fact that one of the tubes opened under mercury gave a quantity of gas not dissolved by water.

As the solution of an alkali metal seemed best adapted for spectroscopic examination, we made an attempt to dissolve sodium in compressed hydrogen. For this purpose a tube with a very large expansion was made, and filled with carefully dried hydrogen. While the stream of gas was still passing, a small piece of sodium was placed in a pocket at the end of the tube, and the aperture closed before the blowpipe. In this experiment we used no manometer, our intention being to increase the pressure slowly and to make it as great as possible. After about half an hour, at a pressure so far as we could judge of about 300 atmospheres, the mercury, which had never come in contact with the solid sodium, was observed to become thick and pasty. At this point the tube burst (no further pressure had been put on) close to the iron cap, and on examining the broken piece small semi-solid globules of mercury were observed adhering to the glass, marking the highest point to which the mercury had reached. These were taken out and placed in water, when small bubbles of gas were observed rising from them. In another experiment a small rod of sodium, quite filling the capillary bore, was observed to be gradually corroded, until only a shell adhering to the glass remained. The very frequent bursting of the tubes, made more frail by the reduction of lead oxide, due to the action of hydrogen on the hot glass, makes the demonstration of the solubility of sodium in hydrogen exceedingly difficult, but the phenomena described, we are convinced, can only be explained on this hypothesis. In several experiments we have seen little pieces of sodium slowly disappear, leaving only the thin shell of oxide formed round them while they were being placed in the tube. There seemed in many cases to be a sudden chemical action, for the tube burst, not while pressure was being applied, but often several minutes after the pressure screw had been advanced. A beam of light passed through the tube showed no absorption when examined by the spectroscope.

Having described our experiments, it remains only for us to consider the state of the solvent at a distance above the critical point. We cannot do better than quote Dr. Andrews's consideration of the subject. He says,* "What is the condition of carbonic acid when it passes at temperatures above 21° C. from the gaseous state down to the volume of the liquid without giving evidence at any part of the process of liquefaction having occurred? Does it continue in the gaseous state, or does it liquefy, or have we to deal with a new condition of matter? If the experiment were made at 100° C., or at a higher temperature, when all indications of a fall had disappeared, the probable answer that would be given to this question is, that the gas preserves its gaseous condition during the compression, and few would hesitate to declare this statement to be true, if the pressures, as in Natterer's experiments, were applied to such gases as hydrogen or nitrogen. On the other hand, when the experiment is made with carbonic acid at temperatures a little above 31° C., the great fall which occurs at one period of the process would lead to the conjecture that liquefaction had actually taken place, although optical tests carefully applied failed at any time to discover the presence of a liquid in contact with a gas. But against this view it may be urged, with great force, that the fact of additional pressure being always required for a further diminution of volume, is opposed to the known laws which hold in the change of bodies from the gaseous to the liquid state. Besides, the higher the temperature at which the gas is compressed the less the fall becomes, and at last it disappears." Leaving out of consideration the solubility of sodium in hydrogen, we have had iodide of potassium in solution in alcohol at temperatures much

* *Proc. Roy. Soc*, vol. xxi.

* *Phil. Trans.*, 1869, p. 575.

too high for measurement by the mercurial thermometer, and which may safely be estimated at 150° C. above the critical point (=380° C.). We think therefore we are justified in saying that at this high temperature the solvent was truly gaseous. An examination of Dr. Andrews's curves for carbonic acid shows us that at a temperature only 16° C. above the critical point, the sudden fall in volume corresponding to the boiling line has disappeared, and although the curve does not coincide with the air curve, it is regular, and shows no sign of liquefaction having occurred. Our experiments were made at temperatures further removed from the critical point than this, and as no sudden change in solubility could be detected in passing from the liquid state to these high temperatures, we conclude that, in these experiments, we have further proof of the perfect continuity of the liquid and gaseous states, and also a complete proof of the solubility of solids in gases.

ON THE ARTIFICIAL FORMATION OF THE DIAMOND.*

By J. B. HANNAY, F.R.S.E., F.C.S.

PRELIMINARY NOTICE.

WHILE pursuing my researches into the solubility of solids in gases, I noticed that many bodies, such as silica, alumina, and oxide of zinc, which are insoluble in water at ordinary temperatures, dissolve to a very considerable extent when treated with water-gas at a very high pressure. It occurred to me that a solvent might be found for carbon; and as gaseous solution nearly always yields crystalline solid on withdrawing the solvent or lowering its solvent power, it seemed probable that the carbon might be deposited in the crystalline state. After a large number of experiments it was found that ordinary carbon, such as charcoal, lampblack, or graphite, were not affected by the most probable solvents I could think of, chemical action taking the place of solution.

A curious reaction, however, was noticed, which seemed likely to yield carbon in the nascent state, and so allow of its being easily dissolved. When a gas containing carbon and hydrogen is heated under pressure in presence of certain metals, its hydrogen is attracted by the metal, and its carbon left free. This, as Prof. Stokes has suggested to me, may be explained by the discovery of Profs. Liveing and Dewar, that hydrogen has at very high temperatures a very strong affinity for certain metals, notably magnesium, forming extremely stable compounds therewith.

When the carbon is set free from the hydrocarbon in presence of a stable compound containing nitrogen, the whole being near a red-heat and under a very high pressure, the carbon is so acted upon by the nitrogen compound that it is obtained in the clear, transparent form of the diamond. The great difficulty lies in the construction of an inclosing vessel strong enough to withstand the enormous pressure and high temperature, tubes constructed on the gun-barrel principle (with a wrought-iron coil), of only half an inch bore and 4 inches external diameter, being torn open in nine cases out of ten.

The carbon obtained in the successful experiments is as hard as natural diamond, scratching all other crystals, and it does not affect polarised light. I have obtained crystals with curved faces belonging to the octahedral form, and diamond is the only substance crystallising in this manner. The crystals burn easily on thin platinum-foil over a good blowpipe, and leave no residue, and after two days' immersion in hydrofluoric acid they show no sign of dissolving even when boiled. On heating a splinter in the electric arc it turned black—a very characteristic reaction of diamond.

Lastly, a little apparatus was constructed for effecting a combustion of the crystals and determining their composition. The ordinary organic analysis method was used, but the diamond crystals were laid on a thin piece of platinum-foil, and this was ignited by an electric current, and the combustion conducted in pure oxygen. The result obtained was, that the sample (14 m.grms.) contained 97·85 per cent of carbon—a very close approximation, considering the small quantity at my disposal. The apparatus and all analyses will be fully described in a future paper.

(Received February 25, 1880.)

Extract from a letter from Mr. Hannay, dated Feb. 23:—"I forgot, in the preliminary notice, to mention that the specific gravity of the diamond I have obtained ranges as high as 3·5; this being determined by flotation, using a mixture of bromide and fluoride of arsenic."

* A Paper read before the Royal Society, February 26, 1880.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 94.)

VI. ON THE USE OF THE PERIODIC LAW FOR THE COMPLETION OF OUR KNOWLEDGE RELATIVE TO THE FORMS OF CHEMICAL COMPOUNDS.

AT the time when the discovery of metaleptic phenomena created a change in the ideas of chemists, all the chemical reactions were considered as cases of substitution, and the theory of types was drawn up under several forms. Gerhardt was even inclined to think that the reaction by which C_2H_4 combines with Cl_2 was an act of substitution of H by Cl, and a formation of $C_2H_3Cl+HCl$. Everything which did not correspond with these ideas was declared to be molecular addition. $C_2H_3Cl+HCl$ in the preceding example should, according to this, form a whole body like $CNa_2O_3+10H_2O$. Although the interpretation of chemical phenomena has, thanks to the theory of types, acquired a simplicity and harmony which was before impossible, this theory nevertheless shared in a measure the fate of the doctrines which preceded it, and that was because the notions on which it was based were expressed in a too absolute manner, and because it neglected a large class of phenomena and considered them to be molecular additions. It was not until attention was turned towards the study of metallo-organic compounds (towards 1855), in which the phenomena of substitution and addition* are represented both in the same degree, that the phenomena of addition commenced to receive the attention they deserved: Frankland, Cahours, &c., have introduced to chemistry the idea of there being a limit to chemical compounds. These ideas have since been applied to the carbon compounds.†

The ideas which have been entertained about *limits*, about *saturated* compounds, about the aptitude of *non-saturated* compounds to show phenomena of addition, ideas connected with the opinions relating to substitutions, correspond, in my opinion, to the most complicated problems that chemical investigation can propose. However, the theory of limits, in its primitive form and free from everything tending towards hypotheses, has not settled itself in the science of chemistry; for it is in the destiny of science that the most important discoveries of an era lead first of all to extreme hypotheses. I consider as such the theory of atomicity at present in vogue.

Couper, later on Kékulé, and after them others, in comparing the composition of saturated compounds of an element with chlorine or hydrogen, have thought that each

* I have treated in detail, in the *Bulletin de l'Académie des Sciences de St. Pétersbourg*, 1858, the differences between the phenomena of addition and substitution in the sense of the unitary theory, and bearing in mind the modifications arisen from the physical properties

† Notably in my memoir, "Essai d'une Théorie sur les Limites (*Ibid.* vol. v., 1861.)

element was capable only of saturating a certain number of equivalents of all the other elements. But not stopping there, these investigators, and afterwards their successors, thought that it was possible to deduce the preceding hypothesis from determined conditions relative to the fixation of elements in the molecule. Everybody is aware of the excellent results which have been arrived at in starting from this hypothesis in the study of isomerics: but all the same it must not be forgotten that other hypotheses, now neglected, have had these periods of glory and popularity. The discoveries due to adepts of the electro-chemical theory have been shown up in a new manner by the theory of types. But the discoveries concerning isomerics are completely explained without it being necessary to have recourse to the hypothesis of the combination of elements in the molecule by parts of their affinity. We have a very simple manner of showing this circumstance, which was discovered and interpreted exactly from cases of isomerism in the aromatic and other compounds, even without using the preceding theory, and uniquely by a clear idea of substitutions. Below are given some considerations directed against the different forms of the hypothesis of valence or of atomicity.

1st. The corner-stone of this hypothesis is the division of all chemical compounds into atomic and molecular compounds; but the hypothesis only touches on the compounds of the first mentioned kind; molecular compounds are neither considered nor generalised. The above-mentioned division—a division which has long existed—lacks any solidity; it is so artificial and so arbitrary that even chloride of ammonium and perchloride of phosphorus are by some people considered as molecular compounds. In reality, there is not one single character which sharply defines the limit of the category of the above-mentioned compounds. That they contain complete independent molecules, one by the side of the other; that they are incapable of being turned into vapours; that there is only a feeble modification in the chemical reactions when combination takes place;—all these are insufficiently distinct characters; if not, $PtCl_4 = PtCl_2 + Cl_2$ and $KClO_4$, &c., might be considered as molecular compounds. But if it is impossible to establish any limit between the molecular and atomic compounds, the possibility of fixing the equivalence or the atomicity of element, above all when based on the compounds with hydrogen and chlorine, disappears. $PtCl_4$ is not a limited compound, for it can still combine with $2HCl + 6H_2O$ or with $8H_2O$, and other molecules can be substituted for these last-named. The formula of hydro-fluosilicic acid, SiH_2F_6, which is reproduced for many elements, shows, so to speak, the hexatomicity of silicium, whilst this element, compared with hydrogen and chlorine, is tetratomic. To prove that this form of combination is not determined by the presence and by the particular properties of fluorine, it suffices to mention PtH_2Cl_3 and the corresponding salts, as well as the double cyanides.

2nd. To appreciate the atomicity of elements, we start with combinations with hydrogen, although out of the sixty-three elements which are known up to the present seventeen only have been combined with it. Further, hydrogen only gives one compound with one atom of an element, whilst other elements, and even chlorine, can furnish several compounds. Therefore, it is at least of not much practical value to judge compounds of an element with other elements according to its compounds with hydrogen. Carbon itself only forms with H one compound, CH_4, and not even CH_2, although it gives with oxygen CO_2 as well as CO. The existence of molecules $SnCl_2$ and $SnCl_4$, HgCl and $HgCl_2$, PCl_3 and PCl_5 has always embarrassed the partisans of the hypothesis of the atomicity of elements, precisely because we started from compounds with hydrogen, and because hydrogen only gives one form of combination.

3rd. All the elements except fluorine can enter into combination with oxygen. These compounds are the most widely spread of any in Nature. Their chemical character is very distinctly shown; many elements give several compounds with oxygen. However, the hypothesis of atomicity does not furnish us with any law relative to the number of atoms of oxygen, because, according to this hypothesis, oxygen can enter into any complete molecule in its character of a biatomic element. A given body, RM, can receive an indefinite number of molecules of oxygen; it then forms what the hypothesis in question calls a *chain*—

$$R—O—O—O^n—M.$$

The best example which can be given is the following:—

KCl,
K—O—Cl,
K—O—O—O—Cl,
and K—O—O—O—O—Cl.

In other cases this hypothesis is not considered admissible; thus there is no chain in CO_2. The instability of the cateniform compounds of oxygen cannot serve as a distinctive character, for CO_2, H_2O, Cl_2O, are all one as easily decomposed as the other, although at different temperatures. PtO_2, again, is more easy to decompose than $KClO_3$, in spite of the admitted difference relatively to the mode of fixation of the atoms. Further, we cannot imagine why KClO is more unstable than $KClO_3$, nor why the longest chain, $KClO_4$, is more stable than the shortest chains. But what there is worthy of note is that the forms of combination of oxygen, like hydrogen and other elements, are held between narrow and analogous limits. This may be noticed at first sight if we take care to put next to each other those forms of combination which contain the most oxygen, OsO_4, $KClO_4$, K_2SO_4, K_3PO_4, K_4SiO_4. The periodic law, in fixing the limit of oxygenated compounds, fills up an important gap in the atomic theory.

4th. The most logical partisans of the above-mentioned hypothesis are those who see in atomicity a fundamental or *invariable* property of atoms. As a rule, they further hold that free affinities cannot exist in molecules. They consider carbon to be invariably tetratomic, and nitrogen always triatomic, &c. However, it is necessary to give in before facts. Thus, at present, the greater number of partisans of atomicity consider this property to be variable. In plainer words, to admit that the atomicity of an element is variable is almost to renounce the hypothesis in question; this hypothesis is no longer anything but that of the number of equivalents in an atom; atomicity varies like the equivalents of elements, according to the law of multiple proportions. If atomicity is a variable property, if we admit that in the greater number of cases a part of the bonds of affinity is latent, we must give up all idea of determining the atomicity. Sulphur was long considered to be a diatomic element, and this diatomicity was deduced from the compounds SH_2, SHK, SK_2, SCl_2; and SO_2 and SO_3 were declared to be compounds in the form of a chain,—

and

But in this manner the well-known and distinct analogy between SO_2 and CO_2, in which different structures were admitted, remained inexplicable. Further, the analogues of sulphur, Te and Mo, give $TeCl_4$ and $MoCl_4$. The compound SAe_3I was also discovered, so that sulphur was looked upon as being also tetratomic. Let us add that the existence of WCl_6 and SO_3 caused sulphur to be considered as hexatomic; perhaps Cl may sometimes be heptatomic. What is it that proves to us the hydrogen and oxygen cannot be polyatomic? The first severe blow was dealt to this theory when variable atomicities, free and latent bonds of affinity were admitted; the fundamental principles on which the hypothesis is built were shaken to the foundations.

5th. After having lost, by the adoption of variable atomicities, the value of a rigorously scientific system, and after being changed into a tabulated form of equivalents,

the above-mentioned hypothesis could still hold its position in science as a means of representing the forms of combination, on condition of not including the *junction* of elementary atoms in the molecule by means of their bonds of affinity. This part of the hypothesis cannot be put in harmony with the much more certain notions which are now entertained on the construction of matter and on the laws of attraction; we must therefore reject it absolutely. We ought to represent the atoms in a molecule as being in a certain state of unstable equilibrium of reciprocal reactions. The entire system is maintained by forces which belong to each individual particle; for we can only imagine two parts of a whole to be uniquely under the influence of a third part, without giving rise to reciprocal influence, particularly if all that we know concerning these two parts shows that they exercise a distinct and constant chemical action. If we admit that in CH_4 the 4H are only held by one atom of carbon, this idea is not, so to speak, unreasonable in itself; but if one H is replaced by Cl it is difficult to admit that the four atoms (H_3Cl) are held only by the carbon—that the reciprocal powers of attraction of Cl and H remain dormant during or after the reaction. This proposition is not admissible except on the ground that Cl is nearly three times as heavy as carbon. If the term "junction" should only be a conditional expression of the distribution of the elements in space; if it signifies that in the just-mentioned example Cl occupies the *same position* as H—that is to say, that it fulfils the same conditions with respect to carbon and other elements—then this would only be a repetition of what has been stated since the discovery of metalepsy. I have often heard the polyatomic elements, and the elements combined with them, compared to the sun and planets; but this comparison is not tenable, because if one planet were replaced by another, whose mass would be even greater than that of the sun itself, the planetary system would not for that reason cease to exist. The partisans of atomicity may suppose that chemical attraction, differently to universal gravitation, does not depend on the mass, but only on the atomicity of the elements. The periodic law in recognising a strict dependence between the atomicity and the mass of atoms completely annuls such an hypothesis, and authorises us to suppose that chemical attraction, like any other attraction, depends upon the masses.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Ordinary Meeting, February 28, 1880.

Prof. W. G. Adams in the Chair.

A paper was read by Mr. Ridout on "*Some Effects of Vibratory Motion in Fluids.*" It was found by Savart and Tyndall that jets of water were sensitive to notes, or air vibrations, like flames, and the author conceived the idea of vibrating the jet of water from within. To do this he caused an electro-magnetic arrangement to pinch the tube conveying the water 400 to 500 times per second so as to communicate a vibratory motion to the stream of fluid. The issuing jet spread out in two streams, beautifully broken into drops, and representing the fundamental note. When the pinching lever vibrated irregularly, harmonics were observed. When the water was thrown into vibration in two different planes the resulting jet rotated in the tube. Froude's deduction that a liquid moving in a tortuous tube has a tendency to straighten the tube was illustrated by oscillating a pipette with its nozzle in a vessel of water, and filling a coloured liquid into it, which is seen to flow from the nozzle through the water in a tortuous line. By giving the pipette also a motion round its axis the line becomes a spiral; a sounding body produces no disturbance in the stream. The author also showed that the cardboard experiment of M. Clement Desormes can be extended to water. In this experiment a card is attracted to another card by blowing a jet of air through the latter upon the surface of the former. Mr. Ridout allows a jet of water to flow out of a glass tube with a cup-shaped mouth upon the surface of a glass ball, and when the ball is within a certain distance of the mouth it is attracted towards the latter and sticks in the mouth. In explanation of this fact it was shown that the ball and cup remained in such a position that the outflow of water was greater than if the globe had been entirely absent.

Prof. Perry explained this action by the hydrodynamical fact that the pressure is less at the centre of the mouth of the cup than at the edges.

Prof. Guthrie said that he had tried a similar experiment with a funnel-shaped mouth and a glass cone, but failed. He surmised that perhaps the cohesion of the water for itself as it formed a shell round the ball might help to cause the success of the ball method.

Prof. Adams pointed out that with the cup and ball there was less difference of head of water between the centre of the mouth and the edge where the water escaped than with the funnel.

Dr. Stone stated that he had been able recently to imitate many physiological sounds, such as the murmur of the heart, by means of constrictions in tubes through which water and air were flowing. His demonstrations were made before the Royal College of Physicians.

Dr. C. W. Wright then read an important paper on a "*Determination of Chemical Affinity in Terms of Electromotive Force.*" After giving a history of the subject, he described his original experiments. These consisted in performing electrolysis of sulphuric acid and measuring the heat evolved in the process, and by recombustion of the materials. A voltameter with spade-shaped platinum electrodes, soldered to stout copper wires, and sealed by a large plug of gutta-percha, was employed for the electrolysis. An ordinary water calorimeter was used to measure the heat given off, as Bunsen's was found to contain sources of loss of heat. The strength of the current employed was varied from 6 webers to $\frac{6}{10}$ weber. The volume of gas produced was measured by Joule's plan. Radiation loss was corrected for by three methods. From an average of eighteen experiments the value of e, the electromotive force, was found to be 1·5038 C.G.S. or volts. Taking the formula—

$$J = \frac{e}{(H+h)x},$$

where J is Joule's equivalent, H is the heat actively evolved, h the heat evolved by recomposition, and x a constant to which Kohlrausch gives the value of 0·000105. Dr. Wright finds that Joule's equivalent should be $4{\cdot}196 \times 10^7$ instead of $4{\cdot}20 \times 10^7$ as given, to answer the formula. The author thinks that Joule's water-friction experiments gave the truest value of J, and that his electric heating experiments gave a result about $\frac{1}{2}$ per cent too low, owing to the B.A. unit of resistance being about 2 per cent too high and other causes.

Determination of Nitrogen by the Will and Varrentrapp Process.—In case the distillate is coloured Dr. Hauffe titrates it in a flask, closed with a stopper having two orifices. Through one of these a tube passes to the bottom of the flask, serving for the introduction of the standard alkali. Through the other there passes a piece of tubing, which ends just below the stopper, and supporting a moistened pieces of red litmus paper. When this is turned blue by the liberation of ammonia the reaction is at an end. The flask is kept during the process over a source of heat.—*Ber. Oest. Gesell. Förder. Chem. Industrie.*

NOTICES OF BOOKS.

The Retrospect of Medicine, being a Half-yearly Journal containing a Retrospective View of Every Discovery and Practical Improvement in the Medical Sciences. Edited by W. BRAITHWAITE, M.D., and JAMES BRAITHWAITE, M D. Vol. lxxx., July—December, 1879. London: Simpkin, Marshall, and Co.

THIS semi-annual still pursues its course of utility. Among the most interesting facts here brought together we find several cases of poisoning from arsenical wall-papers, recorded by Mr. Jabez Hogg, and, it would seem, well authenticated. Thus, we have successive inmates of a house where brilliant green wall-papers were present seized with the same symptoms,—obstinate skin disease—which resisted medical treatment, but disappeared spontaneously when the sufferers were removed out of the house, and did not return again after the suspected papers were stripped off and others put in their place, though the workmen employed in the alterations had been attacked with cramp, sickness, &c. Thus, according to the methods of "agreement" and of "difference," it may fairly be concluded that the paper was casually connected with the disease experienced. Lastly, the presence of arsenic in the paper was directly established by analysis, and the symptoms observed in the patients were exactly such as are capable of being produced by chronic arsenical poisoning. Two at least of the other cases are equally decisive aud well established. It is very much to be desired that the makers of wall-papers would, of their own motion, discontinue the use of arsenical greens, using Guignet's green, certain aniline greens, and the green of coffee (viridic acid) in their place. If they persist in the employment of arsenical colours the inevitable result will be legislative action so mismanaged as to have an injurious influence upon the tinctorial and decorative arts.

It must not be forgotten, meanwhile, that arsenic is from some inscrutable reason introduced into colours where it can play no useful part, as in umbers and sepia. The comparative rarity of cases of disease distinctly traceable to the random use of arsenic can only be explained by the fact that upon many constitutions it has little immediate effect. Still it is strongly to be suspected that we have here the source of not a few of those mysterious affections which puzzle the practitioner and embitter the life of the patient. For their own sakes, therefore, we would advise all concerned to banish arsenic wherever its presence is not at once necessary and innocuous.

Dr. G. de Gorrequer maintains the unity of the poison in scarlatina, puerperal fever, typhoid, diphtheria, and erysipelas, the results being differentiated according to the constitutional peculiarities and the special circumstances in each case. The contrary view, of a specifically distinct *contagium vivum*, can, he considers, scarcely be upheld without having recourse to the theory of abiogenesis.

In a paper on the treatment of deafness the interesting fact is brought forward that some deaf persons hear best amidst noises, sometimes, indeed, better than those whose hearing is in the normal condition. Hence it has been proposed to use, in such cases, intensified sound as a curative agent.

Concerning certain remedies of no very long standing, such as nitrite of amyl and salicylic acid, the usual conflict of opinion is going on. Some practitioners take a wide and sanguine view of their utility, whilst others are equally impressed with their shortcomings and dangers. Time must elapse before they can find their due level.

Solubility of Alloys of Tin and Lead in Dilute Acetic Acid.—Dr. Ambühl finds that dilute acid readily extracts the lead from such alloys. Banca tin was found perfectly free from lead. English bar tin contains a slight trace.—*Schweiz. Wochensch. Pharm.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Correspondenz-blatt des Vereines Analytischer Chemiker. No. 2, January 15, 1880.

A New Colorimeter.—C. H. Wolff.—This paper cannot be intelligibly reproduced without the accompanying illustrations.

Universal Method of Determining Arsenic.—Millot and Magneune treat the substance in which the arsenic has been detected with nitric acid. The filtered solution is evaporated to dryness, taken up in water acidulated with sulphuric acid, and introduced into a Marsh apparatus. The gases, which contain only arsenic and antimony, are passed into nitric acid, where they are oxidised. After about two hours the reaction is generally at an end, but it is well to ascertain this point by substituting for the delivering-tube of the apparatus a tube drawn out to a fine point. The flame of the escaping hydrogen should not produce the well-known spots upon porcelain. The nitric solution is evaporated to dryness and treated with water, which dissolves only the arsenic acid, leaving undissolved any antimony which may be present. In general the solution is precipitated with magnesia-mixture, and the precipitate is weighed on the filter as ammonio-arseniate of magnesia. The authors, however, prefer the following method. They dissolve 100 grms. crystalline sodium acetate with 50 grms. acetic acid, and make up with water to a litre. Secondly, they dissolve 20 grms. uranic nitrate in ½ litre water, add a few drops of ammonia till precipitation begins, then add exactly as much acetic acid as is necessary, and make up with water to 1 litre. Thirdly, 100 grms. potassium ferrocyanide are dissolved in water to 1 litre. Fourthly, 5 grms. arsenious acid are dissolved in boiling nitric acid, evaporated to dryness, and dissolved in water to 1 litre. The last solution, which contains in 10 c.c. 0·0581 arsenic acid, serves to titrate the uranium solution. 10 c.c. of this normal solution of arsenic acid are mixed with water in a porcelain evaporating basin to about 1 decilitre, 10 c.c. of the sodium acetate solution are added, the whole brought to a boil, and the uranic solution is added drop by drop till the arsenic acid is completely precipitated as uranium arseniate. This is recognised by placing a drop of the boiling solution upon a plate and mixing it with a drop of the ferrocyanide solution, when a faint reddish colouration is produced. The volume of the uranic solution consumed is read off on the burette, 0·5 c.c. is deducted as a correction, and on dividing 0·0581 by the corrected number the contents of the solution per 1 c.c. is obtained. One c.c. of the uranic solution represents, therefore, 0·005 grm. arsenic acid. The same process is then repeated with the solution under examination. On multiplying the number of c.c. of the uranic solution, which are consumed by the value as above ascertained, the quantity of arsenic in the substance is obtained.—*Journal de Pharm. et de Chimie.*

Chemiker Zeitung. No. 1, 1880.

Technological Pictures from Western England.—The first of this series of papers consists of a very full and accurate description of the Cheshire salt trade.

The Austrian Society for the Promotion of Chemical Industry offers a prize of 200 florins in gold for the best treatise on the action of light upon and the consequent destruction of the colouring-matters of indigo, alizarin, and rosanilin, and upon the products generated. A prize of 100 florins in gold is offered for the best research on

the peculiar colouring-matter of jute, and with the object of discovering a process for its destruction without injury to the fibre.

Detection of Free Mineral Acids in Vinegar.—Hager neutralises 20 c.c. of the vinegar with ammonia, pours it into a shallow glass capsule, and exposes it to spontaneous evaporation at a temperature of 70°. If the vinegar is pure nothing remains but a brown imponderable stain. If other acids are present there is a crystalline residue. This process is applicable only to vinegar prepared from alcohol by the "quick" method.—*Pharm. Central-Halle.*

Determination of Acetic Acid in the Acetate and Sub-acetate of Lead.—Dr. F. Salomon prepares for this purpose an acetic acid containing exactly 50 grms. acetic anhydride per litre, and a solution of potassa exactly equivalent. 10 c.c. of the solution to be examined or 2 to 4 grms. of the sugar of lead dissolved in water are placed in a flask holding 100 c.c., precipitated with an excess of the standard potassa solution, the flask filled up to the mark with distilled water, and the whole well shaken. The bulk of the lead is thus precipitated as hydrate, the residue being dissolved in the excess of alkali. After the precipitate has settled, 50 c.c. of the filtrate are mixed with phenol-phthalein, and the standard acetic acid is added till the red colour of the liquid disappears.—*Dingler's Polyt. Journal.*

Acidimetry of Coloured Acids.—Dr. F. Salomon places 2 grms. potassium bicarbonate in the caoutchouc receiver of an apparatus resembling that of Scheibler for the determination of carbonic acid, whilst 10 c.c. of the acid, diluted, if needful, are introduced into the decomposition-vessel. The proportion of acid is calculated from the carbonic acid given off.—*Dingler's Polyt. Journal.*

Bleaching by Means of Hydrocarbons.—A. Viol and G. F. Duflos bleach ostrich feathers by exposure to sunshine in an atmosphere saturated with the vapours of benzine, turpentine, or petroleum.

No. 2, 1880.

Materials, Fuel, and Labour required for the Production of 100 kilos. Ultramarine.—C. Furstenau.—For the finest, or violet quality, the cost is, for materials, 33·08 mark; for fuel, 2·31; and for labour, 9·11, giving a total of 44·5 m. These figures would assume different proportions in England.

Percentage of Anhydride in Fuming Sulphuric Acid.—C. Furstenau.—The author gives his results in the form of a table, and remarks that commercial samples may contain Glauber's salt.

New Glass Weights.—Weights of glass are now manufactured in Leipzig, and are said to be little inferior to those of rock crystal.

An Experiment on Sulphur.—T. Gross mixed the purest commercial "milk of sulphur" with linseed oil, so that to every part of sulphur there was not quite one part of oil, and heated the mixture gradually in a very wide capsule. Offensive vapours were given off, the mass swelled up strongly, and there remained a black porous body, no longer combustible, under conditions in which sulphur burns briskly. If the finely-pulverised black mass is heated with pure concentrated sulphuric acid, sulphurous acid is evolved, and there remains a liquid resembling syrupy sulphur, from which sulphuretted hydrogen throws down a substance soluble in ammonium sulphide, which Gross considers as something hitherto unknown. He states several reasons for doubting the elementary character of sulphur—a question which he is endeavouring to decide experimentally.—*Chem. Central-blatt*, x., 785.

Chloride of Zinc as a Reagent for Alkaloids.—A. Jorissen.—1 grm. of the chemically pure chloride is dissolved in a mixture of 30 c.c. concentrated hydrochloric acid and 30 c.c. water. The solution of the alkaloid or of its hydrochlorate is placed upon the inverted lid of a porcelain crucible, and evaporated upon the water-bath till every trace of moisture has disappeared. Two or three drops of the zinc chloride solution are then poured upon the dry substance, and the lid is again heated on the water-bath, when the characteristic colourations appear. Strychnin appears of a bright rose colour; thebain, yellow; narcein, olive-green; delphinin, brown-red; berberin, yellow; veratrin, red; quinin, pale-green; digitalin, chestnut-brown; salicin, violet-red; santonin, violet-blue; and cubebin, carmine-red. The alkaloids or glucosides examined should be free from admixtures.—*Monit. Industriel.*

Propagation of Disease.—According to the experiments of Dr. Bollinger, the milk of cows suffering from tubercular disease is capable of communicating this affection to human beings. As 5 per cent of cows when advanced in life suffer from this disease the danger is considerable. Boiling the milk is not a safeguard.

No. 3, 1880.

The Manufacture of Condensed Milk in Middlewich.—The author of this paper, which is a continuation of "Technological Views of Western England," declares that there is not the least foundation for the assertion of Soxhlet that the cream is removed from the milk prior to condensation.

Arsenic in Water-Colours.—G. Wagner.—The writer, a manufacturer of water-colours, protests against the notion that raw sienna containing 1½ per cent of arsenic can prove injurious to persons who lick or suck the brush in drawing. He declares that he has eaten from ⅛ to 1½ of a cake of the colour without experiencing any evil effects, and is prepared to repeat the dose.

The Wine Manufacture in Hungary.—A circular from a firm in Buda-Pest gives the prices of Riesling bouquet, muskatel bouquet, essence of Medoc, essence of Tokay, "red wine colour," deep and fiery, and other liquids for communicating the flavour and colour of wine to artificial mixtures. These ingredients, it is boasted, are exported to Sweden, Russia, and even to South America!

A Method for Detecting and Determining Iodine in Presence of Bromine and Chlorine.—E. Donath.—Whilst potassium dichromate occasions in solutions of potassium iodide no separation of iodine, this result is at once produced by chromic acid. A determination of the liberated iodine is not possible on account of the action of the excess of chromic acid upon sodium dithionite. The iodide of starch is precipitated by solutions of chromic acid as an almost black precipitate. Hence, starch paste cannot serve as an indicator. The iodine is therefore distilled off, and is determined in the distillate by means of hyposulphite of soda. The alkaline bromides and chlorides are not decomposed by concentrated solutions of chromic acid at common temperatures, and the chlorides not even on boiling. Dilute solutions of chromic acid decompose the bromides only to a very small extent at the boiling heat, but the proportion increases with increasing concentration. The method is therefore suitable for accurate determinations of iodine in presence of chlorine, but not when it occurs along with bromine. The solution of chromic acid employed contains from 2½ to 3 per cent, and is freed from traces of sulphuric acid by boiling with pure barium chromate.

The Solution of Arsenical and Antimonial Compounds.—E. Donath.—Rammelsberg's method of separating arsenic and antimony from the metals of the fifth group by fusion with sodium carbonate and sulphur and solution in water, has the drawback that the aqueous solutions contain highly sulphuretted compounds, which, on exposure to the air, deposit incrustations of sulphur, and on decomposition with hydrochloric acid precipitate the sulphides of arsenic and antimony mixed with much sulphur, which is very inconvenient in dissolving the arsenic sulphide, or in converting the antimony sulphide into antimonic acid. By using hyposulphite of soda, pre-

viously completely dehydrated by cautious fusion in a capsule, this inconvenience is avoided, and the sulphides thrown down from the aqueous solution of the melt are contaminated with but little free sulphur.—*Zeitschrift für Anal. Chemie.*

Injury to Vegetation by Acid Gases.—Dr. Schröder.—The poisonous action of coal smoke and the fumes of metallurgical and chemical works upon vegetation depends almost exclusively upon the effects of acid gases, especially the sulphurous and the hydrochloric, the former of which is by far the more pernicious. Hence the combustion-products of coal and lignite are the more pernicious the more sulphur is present. Wood smoke has no action upon vegetation. The leaves of trees exposed to sulphurous acid turn brown over their entire surface, whilst hydrochloric acid appears to attack principally the edges. Annual crops resist better than trees. Broad-leaved trees may be thus arranged in the order of their sensitiveness: red beech, birch, lime, poplar, alder, ash, plane, and oak. [The walnut tree is more sensitive than any of the above-mentioned, and from observations in Lancashire we should give the oak a different place.]

New Application of Methyl-chloride.—C. Vincent.—The author applies methyl-chloride, previously liquefied and purified by passage through concentrated sulphuric acid, for the purpose of extracting perfumes from flowers.

MISCELLANEOUS.

Crystallised Carbon in Abstract.—The announcement that Mr. Hannay's paper on the Artificial Formation of the Diamond was to be read at the Royal Society on Thursday, February 26, brought together a large number of Fellows and their friends. After the meeting a scrap of paper with the following lines pencilled on it was picked up not far from where the Treasurer of the Royal Society had been sitting:—

"The crystallised carbon, as diamond known,
Manufactured can be, Mr. Hannay has shown.
From some hydrocarbon set hydrogen free
Near a nitrogen compound, that stable must be,
In the presence of metal—magnesium or sodium—
And the brilliant result is the jewellers' odium."

The London Water Supply.—In his annual report on the quantity and quality of the water supplied to London during 1879, Dr. C. Meymott Tidy remarks as follows:—"The year through which we have passed has been an exceptionally trying one for the water companies—indeed, far more trying than any of which I have had experience. The excessive rainfall has rendered the Thames more frequently than usual thick and turbid. It was to have been expected that the analyses would show a larger average amount of organic matter than in previous years, and the only thing which need surprise us is that it is not greater than results prove it to be. And yet, notwithstanding this, the death rate of London for 1879 is the lowest on record. When I write my next report it is not unlikely that the water supply will have passed out of the hands of the companies, and the management be vested in some other body. I will not venture to predict the future of the London water supply, but I again repeat what I have said more than once before, that in my opinion no better sources of water can be found for the Metropolis, considering all the facts of the case, than the rivers Thames and Lea. I trust, when the companies have passed into the hands of Government, that the general management of the several works will be as good as now, and that the change the public have clamoured for, and the more efficient working that the public expect, will be seen, not merely in lessened taxation, but in the improved health of the people and in a lower death rate."

MEETINGS FOR THE WEEK.

MONDAY, March 8th.—London Institution, 5.
—— Medical, 8.30.
—— Society of Arts, 8. "The Manufacture of India-rubber and Gutta-percha," by Thomas Bolas, F.C.S.
TUESDAY, 9th.—Royal Institution, 3. Prof. Schäfer, "Physiology of Muscle."
—— Civil Engineers, 8.
—— Photographic, 8.
—— Anthropological Institute, 8.
WEDNESDAY, 10th.—Society of Arts, 8. "Recent Advances in the Production of Lambeth Art Pottery," by John Sparkes.
—— Geological, 8.
—— Microscopical, 8.
THURSDAY, 11th.—Royal Institution, 3. Prof. Dewar, "Chemical Progress."
—— London Institution, 7.
—— Royal, 8.30.
—— Royal Society Club, 6.30.
—— Society of Arts, 8. "Balmain's Luminous Paint, by C. W. Heaton, F.C.S.
FRIDAY, 12th.—Royal Institution, 8. Dr. C. William Siemens on "The Dynamo-Electric Current and some of its Applications," 9.
Astronomical, 8.
—— Quekett, 8.
SATURDAY, 13th.—Royal Institution, 3. Mr. Saintsbury, "Dryden and his Period."
—— Physical, 3.

INSTITUTE OF CHEMISTRY.

PRIZES.—DR. FRANKLAND has offered a Prize of £50 for the best Original Investigations involving GAS ANALYSIS; and Dr. C. MEYMOTT TIDY has also offered a Prize of £25 for the best Original Investigation on SPECIAL REACTIONS OF THE ALKALOIDS, AND THEIR SEPARATION FROM ORGANIC MIXTURES. These Prizes will be open to Associates, and to all persons (except Fellows of the Institute) who shall, before the 31st December next, have qualified for the Associateship in all respects short of passing the prescribed practical Examination, and successful competition for these Prizes will be accepted in lieu of such practical Examination. Further information may be obtained on application to the Secretary, Mr. C. E. GROVES, Somerset House Terrace, W.C.

NOTICE.

It having come to the knowledge of the BADISCHE ANILIN AND SODA FABRIK, of Stuttgart and Ludwigshafen on Rhine, that their Dyes numbered and patented as follows, viz.:—

Acid Magenta S,	numbered	3731,	and patented	8th October, 1877.
Acid Maroon S,	"	3731,	" "	8th October, 1877.
Methylene Blue (Marine Blues),	"	3751,	" "	9th October, 1877.
Fast Red	"	786,	" "	25th February, 1878.

are being used and dealt in by persons who have not obtained the same from the Badische Anilin and Soda Fabrik, or their duly Authorised Agents,

NOTICE IS HEREBY GIVEN that the Badische Anilin and Soda Fabrik are the Sole and only Patentees for the said Dyes, and legal proceedings will be at once instituted against all persons found manufacturing, dealing in, or using the same, or having them in their possession, unless the packages or tins bear the patent labels and trade-mark of the Badische Anilin and Soda Fabrik.

All persons supplying to the Badische Anilin and Soda Fabrik, or to Messrs. Schott, Segner, and Co., of 4, Charlotte Street, Manchester, full proof of any infringement of the said Patents of the Badische Anilin and Soda Fabrik will be suitably rewarded.

Dated this 1st day of March, 1880.

(Signed) SALE, SEDDON, HILTON, and LORD,
Solicitors, Booth Street, Manchester.

TO DYERS AND CAPITALISTS.

TO BE DISPOSED OF, in one of the Midland County Towns, in consequence of the ill-health of the Proprietor, an OLD ESTABLISHED and EXTENSIVE BUSINESS, with several Branches, in GARMENT DYEING and CLEANING. The Purchase Money, including Goodwill and Fixtures, would amount to about £7000, the Stock-in-Trade being taken by valuation. The FREEHOLD PREMISES, on which the principal business is carried on, could be Sold or Rented at the option of the purchaser.—Apply by letter to "Tintoretto," care of Messrs. SCRIVENER, GILL, and Co., 40, New Bridge Street, Ludgate Circus, London, E.C.

SULPHOCYANIDE OF AMMONIUM.

Wanted, Rough Crystals of the above.—Please state price per cwt.—Address, R., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London E.C.

Crown 8vo., with 94 Engravings, 12s. 6d.

SANITARY EXAMINATIONS OF WATER, AIR, AND FOOD. A Vade-Mecum for the Medical Officer of Health and others. By Cornelius B. Fox, M.D.

"The eminent Sanitarian, Dr. Cornelius Fox, the learned author of 'Ozone and Antozone,' has had the happy thought to publish for the use of his colleagues of the Public Health Service, a Handbook which will enable them to undertake with rapidity and precision those researches and analyses indispensable for the determination of the state of water, air, and food. . . . . This book is of incontestable practical utility, since the object aimed at is accomplished by simple methods, without necessitating a technical knowledge of Experiment Chemistry, and without the aid of great Chemical Laboratories."—*Journal d'Hygiène.*

J. and A. CHURCHILL, New Burlington Street.

Sixth edition, 2 vols., 8vo., 42s.

COOLEY'S CYCLOPÆDIA OF PRACTICAL RECEIPTS AND COLLATERAL INFORMATION IN THE ARTS, Manufactures, Professions, and Trades, including Medicine, Pharmacy, Hygiène, and Domestic Economy. Designed as a comprehensive supplement to the Pharmacopœia and General Book of Reference for the Manufacturer, Tradesman, Amateur, and Heads of Families. Edited by Professor Tuson, F.C.S., assisted by several Scientific contributors.

J. and A. CHURCHILL, New Burlington Street.

WORKS ON CHEMISTRY.

FOWNES' MANUAL of CHEMISTRY. Edited by Henry Watts, B.A., F.R.S. Twelfth Edition.

Vol. I.—PHYSICAL and INORGANIC CHEMISTRY. With 154 Engravings. Crown 8vo. 8s. 6d.

Vol. II.—ORGANIC CHEMISTRY. With Engravings. Crown 8vo., 10s.

CHEMISTRY, INORGANIC AND ORGANIC. By C. L. BLOXAM, Professor of Chemistry in King's College, London. Fourth Edition, with 295 Engravings on Wood. 8vo. 16s.

By the same Author.

LABORATORY TEACHING; or, Progressive Exercises in Practical Chemistry. Fourth Edition, with 89 Engravings. Crown 8vo. 5s. 6d.

PRACTICAL CHEMISTRY, including ANALYSIS. By JOHN E. BOWMAN. Edited by Prof. Bloxam. Seventh Edition, with 98 Engravings. Fcap. 8vo. 6s. 6d.

NOTES FOR STUDENTS IN CHEMISTRY; a Syllabus. By ALBERT J. BERNAYS. Professor of Chemistry at St. Thomas's Hospital. Sixth Edition. Fcap. 8vo. 3s. 6d.

HOW TO TEACH CHEMISTRY. Six Lectures. By EDWARD FRANKLAND, D.C.L., F.R.S. Edited by G. Chaloner, F.C.S. With 47 Engravings. Crown 8vo. 3s. 6d.

CHEMICAL COMPOSITION of FOODS, Waters, Soils, Minerals, Manures, and Miscellaneous Substances. Compiled by E. T. KENSINGTON, F.C.S. Fcap. 8vo. 5s.

INTRODUCTION TO INORGANIC CHEMISTRY. By W. G. VALENTIN, F.C.S., late Principal Demonstrator in the Science Training Schools. Third Edition, with 82 Engravings. 8vo. 6s. 6d.

By the same Author.

A COURSE OF QUALITATIVE CHEMICAL ANALYSIS. Fifth Edition, with 19 Engravings. 8vo. 7s. 6d. [*Nearly ready.*

HANDBOOK OF VOLUMETRIC ANALYSIS. By FRANCIS SUTTON, F.C.S, Norwich. Third Edition, with Engravings. 8vo. 15s.

INSTRUCTION IN CHEMICAL ANALYSIS. By C. REMIGIUS FRESENIUS. Translated by Arthur Vacher.

QUALITATIVE. Ninth Edition. 8vo. 12s. 6d.
QUANTITATIVE. Vol. I. Seventh Edition. 8vo. 15s.

HANDBOOK OF CHEMICAL TECHNOLOGY. By Dr. Wagner, of Würzburg. Translated by Wm. Crookes, F.R.S. With 336 Wood Engravings. 8vo. 25s.

PRACTICAL CHEMISTRY and QUALITATIVE INORGANIC ANALYSIS. Specially adapted for Schools. By F. CLOWES, D.Sc. Lond., Senior Science Master at the High School, Newcastle-under-Lyme. Third Edition, with Engravings. 8vo. 7s. 6d.

INTRODUCTION TO COMMERCIAL ORGANIC ANALYSIS. By ALFRED H. ALLEN, F.C.S, Lecturer on Chemistry at the Sheffield School of Medicine. Vol. I., Cyanogen Compounds, Alcohols and their Derivatives, Phenols, Acids, &c. 8vo. 10s. 6d.

J. and A. CHURCHILL, New Burlington Street.

THE CHEMICAL NEWS.

Vol. XLI. No. 1059.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Continued from page 106.)

I would add that the theory of atomicity arose from the study of the organic compounds of carbon, to which it is easily applied. The legitimacy of this application is shown by the two following considerations:—

1. *Carbon takes an equal number of equivalents of hydrogen and of oxygen*, and at its limit gives the compounds CH_4, CO_2, CCl_4. It is otherwise with the elements of other groups (see Table II.).

The elements of the fifth group give RH_3 and R_2H_5, that is to say, that they are triatomic compared with hydrogen, and pentatomic compared with oxygen; the elements of the sixth group are biatomic compared with hydrogen, and hexatomic compared with oxygen, &c.

2. As far as we know carbon does not give any so-called molecular compounds, like so many of the other elements do. The combination of oxalic acid and water,—

$$C_2H_2O_4,2H_2O,$$

belongs to the type of hydrates, because it corresponds to the limit compound C_2H_3, in which all the H are replaced by (OH); $C_2(OH_6)=C_2H_2O_4,2H_2O$; in separating by a comma the water of crystallisation, we only want to express this well-known fact that an atom of carbon in a compound retains only a slight residue of water. The incapacity of carbon to form molecular compounds is noticed particularly when we compare it with silicium, analogous in its other properties, and giving like carbon limiting compounds, SiH_4, SiO_2, and $SiCl_4$. If in organic compounds we replace a quantity of carbon by silicium, bodies analogous in many respect to the veritable carbon compounds are produced, as the splendid researches of Friedel and Ladenburg have shown; nevertheless, there exists a great difference between the two elements, and it consists principally in the faculty possessed by Si of forming molecular compounds. Perchloride of silicium combines, like $TiCl_4$, BCl_3, PCl_5, SCl_2, &c., with other chlorides, and forms moderately stable bodies, whilst chloride of carbon, as far as we know, is not capable of so doing.* The aptitude of Si for molecular combinations does not arise only from the existence of SiH_2F_6, and hydrates of silicic acid (we do not know of any hydrates of CO_2), but also from numerous properties of silica. This last point ought to be cleared up. When we compare the compounds of carbon with those of silicium, we constantly notice that *the compounds of silicium boil at lower temperatures than the corresponding compounds of carbon* (or sometimes, but very rarely, at the same temperature), *and that they have a greater* (or equal) *molecular volume*. There is an intimate relationship between the two phenomena:—

	Molecular Volume.	Boiling-points.
CCl_4	94	76°
$SiCl_4$	112	57
$CAe_4=C_9H_{20}$	,,	about 120
$SiAe_4=SiC_8H_{20}$	,,	150
$CaCO_3$	37	,,
$CaSiO_3$ (wollastonite)	41	,,
$CHCl_3$	78	60
$SiHCl_3$	84	34
$C(OC_2H_5)_4$†	186	158
$Si(OC_2H_5)_4$	201	160

* This question should be very carefully studied.
† Basset's ether.

We can admit that, in other cases also, analogous phenomena will spring up; however, we have contrary evidence in comparing CO_2 with SiO_2. The boiling-point of silicic acid is at a temperature we cannot attain, and in accordance with this the volume is less than that of carbonic anhydride, liquid or solid. The volume of CO_2 is about 44, the volume of amorphous $SiO_2=27$. This contradiction can be explained only by the hypothesis of a case of polymerism of silica ($Si_n O_n$), because the phenomena of polymerisation are always accompanied by a diminution of volume and a rise in the boiling-point.*

But as the substances liable to other additions are the only one which become polymeric (CH_2, C_2H_2, C_5H_8, for example), because the polymerisation is an act of combination of homogeneous molecules, the differences between silica and carbonic acid betray the property which silicium has of forming complicated compounds of this kind, compounds which are unknown in the history of carbon.

Carbon by its principal properties is clearly distinguished from the other elements; it is for this reason that a number of conclusions, completely exact when they apply to carbon compounds, are not true when we wish to apply them to other elements. We have a proof of this in the ideas on constant atomicity, which ideas, confirmed by the study of organic compounds, do not apply to the compounds of other elements. If, from the doctrine relative to the chemical structure of compounds founded on the atomicity of elements, we exclude all that is in contradiction to the mechanical theory of the structure of bodies, and to the ideas which have only been confirmed specially by carbon, there remains that which has already supplied the theories of substitution, and of the limits of chemical combination. The hypothesis of atomicity appears to me to be unsteady, perhaps because it has led to no general law, and is not built on solid foundations. If to what remains of the atomic theory we add what is given by the periodic law, we arrive at the following general idea *of the forms of chemical compounds*.

All the ideas on the structure of chemical compounds rest on three principal propositions. I will try and make them clear.

1. *The Principle of Substitution.*—When a molecule divides into two parts, these parts are equal (they can replace one another). This principle is comparable to the principle of mechanical conservation, and the equality of forces, in virtue of which, action and reaction are equal. It is for this reason that H_2 and O, HO and H, CH_3 and H, CH_2 and H_2, C and H_4, Cl and H, K and Cl, K and H, NH_2 and H, NH_4 and Cl or H or K, &c., are equivalent. The phenomena of substitution, homology, &c., are thus more generalised.

2. *The Principle of Units.*—When a molecule decomposes, one at least of the molecules of decomposition can combine with a quantity of elements equivalent to the second molecule formed simultaneously. C_2H_4 formed from C_2H_6O by eliminating one molecule of H_2O, can combine with Cl_2 (equivalent to H_2O), with HCl, &c. This principle comprises the phenomena of addition, the production of limited forms, as well as of body far from the limit, &c.

3. *The Periodic Principle.*—The highest forms of combination of an element with hydrogen and with oxygen, and consequently with equivalent elements, are determined by the atomic weight of this element, of which they are a periodic function. This principle keeps down the number of possible forms, but it still requires elaboration.

I will now explain the most important consequences of these three principles.

All elements can combine with hydrogen and produce one of the four following forms: RH, RH_2, RH_3, RH_4. In each form one hydrogen can be replaced by an equivalent residue of another form (up to a certain limit deter-

* In adopting polymerisation, we can also explain other properties of silica. See "Principles of Chemistry" (in Russian), 1st edition, chap. xvii., vol. ii.

mined by the nature of the element). For example, from CH_4 we can obtain CH_3NH_2, N acting here as an element which gives NH_3. Another substitution is possible in the body formed, viz., CH_2ClNH_2. The order in which substitution takes place has not any influence on the properties of the bodies; it depends entirely on the form under which the substitution is effected. Thus—

$$CH_3NH_2 = NH_2CH_3,$$

but CH_2ClNH_2 is simply isomeric with CH_3NHCl. In this manner homology and isomerism are explained. When in a compound of an element with hydrogen one hydrogen is replaced by equivalents of hydrogen compounds of the same element, homologues are formed.

The following homologues correspond to CH_4:—

$$C_nH_{2n+2}\begin{cases}CH_3CH_3\\CH_3CH_2CH_3\\CH_3CH_2CH_2CH_3\end{cases}$$

or—

$$CH_3CH\begin{cases}CH_3\\CH_3\end{cases}$$

&c.

The following homologues correspond to phosphuretted hydrogen:—

$$P_nP_{n+2}\begin{cases}PH_3\text{ (gaseous phosphuretted hydrogen)}\\PH_2PH_2\text{ (liquid phosphuretted hydrogen)}\\PH_2PHPH_2,\\PH_2PHPHPH_2\text{ and }PH_2P(PH_2)_2,\text{ &c.}\end{cases}$$

To sulphuretted hydrogen, S_nH_2 corresponds; SH_2; SHSH; SHSSH.

The number expressed by n can have different values, according to the nature of the element. For C, as far as we know, this number is unlimited; for N it is 1; for P it is not greater than 4; for S it equals 6. The last case seems to show a dependence between the value of n and the number of atoms forming a molecule, because the molecule of sulphur is S_6; we can thus foresee that the molecule of ozone O_3 will give O_3H_2, as O_2 gives O_2H_2; but O_3H_2 will be still more unstable than H_2O_2, because O_3 is more unstable than O_2.

Further, the limited compounds of which we have spoken can form, with elimination of molecules of hydrogen, hydrogen compounds far from the limits. It is thus that P_4H_6 is changed in P_4H_2 (solid phosphide of hydrogen) but losing $2H_2$. It is thus that by means of C_nH_{2n+2}, we obtain the series C_nH_{2n}, C_nH_{2n-2}, &c.

Up to this point our manner of looking only differs in appearance with that adopted by the partisans of the atomicity of elements; they are really similar up to here. But we have only spoken of hydrogen and its compounds. Further on we shall meet with essential differences; but we must notice that there are only some few elements capable of giving hydrogenated compounds, and above all giving homologous bodies. Carbon only, as far as we know, gives the bodies in any great number.

(To be continued.)

The Action of Light and the Function of Chlorophyll in Plants.—M. Pringsheim.—The author draws the following conclusions:—The possibility of the destruction of chlorophyll by light in the living plant is fully shown. It is proved that plants take up oxygen even in the full sunshine. The colouring-matter of chlorophyll by means of its strong power of absorbing light reduces the quantity of respiration by rendering inactive that part of the rays which possess the greatest photo-chemical activity. The substances which are consumed in the respiration of plant-cells are now distinguished. From the extinction of the blue rays in the chlorophyll it becomes manifest why the rays of mean refrangibility are most efficacious in the evolution of oxygen by plants, and why the assimilation-curve in plants coincides with the brightness-curve of the human eye.—*Berlin Monatsber.*, 1879, 532.

A NEW METHOD FOR THE ALKALIMETRIC DETERMINATION OF SULPHATES, AND ITS APPLICATION TO THE COMMERCIAL ASSAY OF SALTCAKE.

By J. GROSSMANN, Ph.D.

FROM the title of this paper it will be seen that for the present I introduce my method only as a method for the commercial assay of saltcake or like products. Though no doubt it will prove of very general applicability (with the exception of cases where sulphates are in neutral solution, besides oxalates, tartrates, phosphates, &c.), I shall confine myself here to its special application, as so far I have investigated the accuracy of this method only with regard to the conditions under which I make the assay of saltcake. I am engaged in studying the results which this method yields under different conditions, and on a future occasion I shall show how far it may be applicable for the determination of small quantities of alkali sulphates, of mixtures of potash and soda (by indirect analysis), of sulphates of the metals, &c. The method is based on the following well-known reactions:—

If we add an excess of a cold saturated solution of barium hydrate to the solution of sodium sulphate, barium sulphate is precipitated and sodium hydrate and barium hydrate are left in solution.

$$Na_2SO_4 + (x+1)BaO_2H_2 + yH_2O = 2NaOH + xBaO_2H_2 + BaSO_4 + yH_2O \qquad (1).$$

If we now separate the precipitate of barium sulphate from the solution of barium hydrate and sodium hydrate and pass carbonic acid through the clear filtrate, barium carbonate is precipitated and sodium hydrate left in solution.

$$2NaOH + xBaO_2H_2 + xCO_2 = 2NaOH + xBaCO_3 + xH_2O \qquad (2).$$

And the quantity of sodium hydrate formed in these reactions is equivalent to the quantity of sodium sulphate originally in solution, and can be estimated by means of standard sulphuric acid.

It is evident that the operation cannot be performed from beginning to end in the same vessel. For we are obliged to use an excess of carbonic acid, and thus some barium bicarbonate and sodium carbonate and bicarbonate are formed; and it is well known that the latter to a certain extent decompose barium sulphate, forming again sodium sulphate. It will now be easily understood why I use the *modus operandi* which I shall now describe.

The neutral solution of sodium sulphate (3·55 grms.) is put into a 500 c.c. flask, a measured quantity of barium hydrate in solution (250 c.c. of a cold saturated solution) is added in excess, the flask filled up with water, and shaken up. Of the filtered clear liquid 250 c.c. are put in an ordinary flask, carbonic acid passed through for about ten minutes, and then the contents of the flask boiled so as to decompose any barium bicarbonate which may be in solution. After cooling, the contents of the flask are again transferred to the 500 c.c. flask, the latter filled up with water to the mark, shaken up, and filtered. 250 c.c. of the filtrate—*i.e.*, one-fourth of the original quantity used—are then titrated with one-fourth normal sulphuric acid. The number of c.c. of one-fourth normal acid used multiplied by two will give the percentage of sodium sulphate.

There are, however, four sources of error in the experimental working of this method which make certain corrections necessary. They arise—

(1.) From the impurities of the caustic baryta.
(2.) From the inaccuracy of the graduated vessels used.
(3.) From the precipitate formed in them.
(4.) From certain constant losses.

The commercial caustic baryta always contains barium nitrate, and sometimes barium chloride. It is evident that on adding a solution of barium hydrate which con-

tains barium nitrate to a solution of sodium sulphate, a quantity of the latter, equivalent to the quantity of the barium nitrate present, will be converted into sodium nitrate, and thus escape our alkalimetric test. I am not in a position to say whether this error will take place in the first or second part of the reaction, and at the present state of our knowledge it would be very difficult to decide on this point. It is, however, quite immaterial for our purpose at which stage in our experiments this loss occurs, the result being finally influenced in the same way, as will be seen by the following equations :—

$$Ba(NO_3)_2 + Na_2SO_4 = BaSO_4 + 2NaNO_3.$$
$$Ba(NO_3)_2 + 2NaOH + CO_2 = BaCO_3 + 2NaNO_3 + H_2O.$$

It is therefore necessary to measure approximately the quantity of baryta solution used, so as to know the amount of barium nitrate introduced into our process. The latter can be easily ascertained by passing carbonic acid in excess through the cold saturated solution of barium hydrate, boiling, filtering, and precipitating the baryta left in solution by sulphuric acid as usual. 250 c c. of a baryta solution which I used for the experiments given in this paper yielded 0·0280 grm. $BaSO_4$, which corresponds to 0·0171 grm. Na_2SO_4, or 0·96 c.c. of one-fourth normal acid ; and it follows that for every 250 c.c. of this baryta solution I found 0·0171 grm. Na_2SO_4 too little, or that I must add 0·24 c.c. of one-fourth normal acid to the result of my final titration (of one-fourth of the original quantity). If the baryta contain caustic alkali we shall find a corresponding quantity of barium nitrate less by our test ; but it is easily understood that our calculations will not be influenced as long as the barium nitrate is in excess of the caustic alkali, which is always the case in good commercial baryta.

The second source of error, as stated above, arises from the inaccuracy of the graduated vessels used, in this particular instance the 500 and 250 c.c flasks. In these experiments we are only concerned with the relative, and not with the absolute, capacity of the vessels. All that is necessary is that the 250 c.c. flask should hold exactly half the quantity of liquid which the 500 c.c. flask holds. A. Gavalovski* has published an interesting paper on the graduating of standard vessels in cases where this cannot be done directly on the balance. I have modified his method in my experiments, and it will be seen how necessary it is to check the vessels sold as being of a certain capacity.

To do this I dissolved pure barium chloride in about 250 c.c. of water, and added measured quantities of hydrochloric and sulphuric acid. In two experiments 1·7980 grms. yielded 1·7165 grms. $BaSO_4$ (calculated 1·7169 grms. $BaSO_4$), and 1·7742 grms. barium chloride yielded 1·6935 grms. $BaSO_4$ (calculated, 1·6942 grms. $BaSO_4$), the first instance giving 99·98 per cent, and the second 99·96 per cent of the calculated quantity ; and I may assume that on an average I should find 99·97 of the calculated quantity of barium chloride in my experiments.

I then dissolved a weighed quantity of barium chloride in the 500 c.c. flask, filled up to the mark with water, then filled the 250 c.c. flask from it, and added to this quantity the same amount of hydrochloric and sulphuric acid as in the previous experiment, and weighed the barium sulphate. In two experiments 3·4956 grms. barium chloride gave 1·6630 grms. $BaSO_4$, and 3·5058 grms. barium chloride gave 1·6664 grms. $BaSO_4$. Calculated on the basis that I should find only 99·97 per cent of the theoretical quantity of $BaSO_4$, 3·4956 grms. would yield 3·3370 grms. $BaSO_4$, and 3·5058 grms. would yield 3 3467 grms. $BaSO_4$. We find thus the capacity of the quarter-litre flask not 0·5 of the half-litre flask, but 0·4979 and 0·4983, or the mean 0·4981, *i.e.*, 0·95 c.c. too little. It is now very easy to rectify the 250 c.c. flask. We fill it with water up to the mark, and pour into it $13{\cdot}6 \times 0{\cdot}95 = 12\ 92$ grms. mercury, and mark with the diamond the line at which the water stands then. In this way we avoid the troublesome correction which we should otherwise be compelled to calculate each time. To get correct results it is necessary to work as I have shown just now ; *i.e.*, the different determinations of barium sulphate must be made under the same conditions, so that the results be independent of the errors of the method. Fresenius* has lately pointed out again that the determination of barium sulphate by precipitation is not always as accurate as is generally assumed.

* *Chem. Centralblatt*, 1879, p. 236.

The third error arises from the precipitates of barium sulphate and carbonate taking up some space in the 500 c.c. flask, the final results thus being found too high. If we assume that a cold saturated solution of baryta contains about 23 grms. BaO per litre, we shall be near enough for all practical purposes if in our experiments, working with about 3·55 grms. of Na_2SO_4 and 250 c.c. of baryta solution, we subtract 0·4 per cent from our final results for this error.

Three experiments made with 3·55 grms. of pure ignited sodium sulphate gave the following results :—

I.

Used one-fourth normal acid ..	49·37 c.c.
Add for $Ba(NO_3)_2$..	0·24 ,,
	49·61 ,,

$= 99{\cdot}22$ per cent Na_2SO_4.

II.

Used one-fourth normal acid ..	49·21 c.c.
Add for $Ba(NO_3)_2$..	0 24 ,,
	49·45 ,,

$= 98{\cdot}90$ per cent Na_2SO_4.

III.

Used one-fourth normal acid ..	49·37 c.c.
Add for $Ba(NO_3)_2$	0·24 ,,
	49·61 ,,

$= 99\ 22$ per cent Na_2SO_4.

The average of these three experiments gives us 99·1 per cent, and if we subtract from this 0·4 per cent for the precipitate, we get 98·7 per cent instead of 100.

I have not been able to find where this loss of 1·3 per cent takes place, though I hope that my experiments with different quantities of sulphates will throw some light on this point. In working with 3·55 grms. of sulphate in the given dilution it appears that this loss is a constant, and by dividing all our results by 0·987 we will be able to get right results.

It now remains to show the peculiar applicability of this method to the assay of salt-cake and like substances, and this can be done in a few words. The following will be easier understood if I give first a complete analysis which I made of a sample of saltcake.

Moisture	0·49
Insoluble	0 29
Free sulphuric hydrate	0·38
Aluminium sulphate	0·23
Ferric sulphate	0·42
Lime sulphate	1·17
Sodium chloride	2·00
Sodium sulphate (by difference) ..	95·02
	100·00

In order to make a good test of salt-cake it is now necessary to estimate seven constituents, to find by difference the quantity of actual sodium sulphate, which is the only constituent wanted.

We will now consider what happens when barium hydrate is added to a solution of salt-cake. The free acid is precipitated, so are alumina and iron, and the sulphuric

* *Zeitschrift fur Analytische Chemie*, 1880, p. 53.

acid combined with them and with lime. The lime is partly thrown down as such, and what is left as lime in solution is precipitated as carbonate in the second operation. Thus, whatever other sulphates be present, only the sodium sulphate is given in our test; and by one simple test we are thus able to get a result which formerly could only be attained by a tedious complete analysis.

The saltcake, of which I have given a complete analysis above, was tested by my alkalimetric method. 3·55 grms. required—

One fourth normal acid	46·93 c.c.
Add for $Ba(NO_3)_2$..	0·24 „
	47·17

$=94·34$ per cent Na_2SO_4.

$(94·34-0·40)=93·94$.

$93·94 : 0·987 = 95·2$ per cent Na_2SO_4.

We find thus by the alkalimetric test 95·2 per cent Na_2SO_4, whereas the analysis gives 95·02 per cent. If we consider how difficult it is to wash soda salts completely from precipitates, we are not astonished to find the result too low in the complete analysis, as in five precipitates a very minute quantity will make up 0·2 per cent.

It is hardly necessary to point out that none of the figures for the correction of the four errors enumerated above, and given in this paper, can be used by anyone else working by this method, but that they must be ascertained in every individual case. I may also mention that it is absolutely necessary to ascertain after the first operation that there is no sulphate, and after the second (before titrating) that there is no baryta in solution.

St. Helens, Lancashire, February, 1880.

ON THE REDUCTION OF CHLORIDE OF GOLD BY HYDROGEN IN THE PRESENCE OF PLATINUM.

By Dr. D. TOMMASI.

When a solution of chloride of gold is acted on by hydrogen in the presence of platinum the chloride of gold is reduced to the metallic state. To what is this reduction due? Let us examine the facts:—An aqueous solution of chloride of gold has no action on a strip of platinum, neither has the hydrogen any action on the chloride of gold; but the platinum put in the presence of hydrogen has the property of absorbing a certain quantity of this gas.

The starting-point of the reduction of the chloride of gold is in the condensation of the hydrogen on the platinum. The platinum in absorbing the hydrogen disengages heat, and it is precisely this heat which determines the reaction between the hydrogen and the chloride of gold. This reaction once commenced can continue of its own accord, and give place, like all chemical reactions, to an electric current.

The electric current observed by Dr. Phipson is not, therefore, the initial, but the final action; the disengagement of electricity does not start the reaction between the chloride of gold and the hydrogen, but it is, on the contrary, this chemical reaction which starts the electric current. What is, in Dr. Phipson's opinion, the cause of this reaction is, according to my idea, the effect of it.

By substituting for the strip of platinum another metal which has no action on the chloride of gold, and which does not absorb hydrogen, I am convinced that no reduction will take place; and I believe that if, instead of platinum, palladium were used, the reduction of the gold would take place with much greater energy, because palladium can absorb much more hydrogen than platinum absorbs.

ON VESBIUM AND NORWEGIUM.

By C. RAMMELSBERG.

Signor A. Scacchi in a session of the Neapolitan Academy of Sciences, made a communication on the examination of certain green and yellow incrustations which cover the fissures in the lava of Vesuvius of the year 1631. They consist of silicates, and contain copper, lead, and a body which he considers as new, and which he designates as Vesbium, from the old name of Vesuvius. The small quantities of this substance have allowed merely preliminary investigations. It appears to be a metallic acid of a red colour, giving colourless alkaline salts, which turn yellow on the addition of an acid. The silver salt is red or orange; the copper salt, a yellowish green. Sulphuretted hydrogen gives a brown precipitate and a blue liquid which is rendered brown by zinc.

Before the blowpipe it communicates to microcosmic salt a yellow colour in the outer flame and a green in the inner.

S. Scacchi does not believe in the presence of molybdenum or vanadium, though many considerations render the latter not improbable.

The memoir contains no numerical facts beyond the statement that the silver salt contains 48·8 per cent of silver ($AgVO_3=52·1$ Ag).

More definite are the statements made by Dahll in the *Zeitschrift d. Geol. Gesell.* (vol. xxxi., p. 480), on the supposed new metal from the red nickel pyrites of Krageröe, which he calls Norwegium (Ng). He finds it white, not very ductile; sp. gr. 9·44; melts at 350°, and dissolves in nitric acid with a blue colour, which becomes green on dilution. On the reduction of the brownish oxide in hydrogen the proportion of oxygen was found, 9·6 to 10·15. On the supposition NgO we have Ng = 150·6 or 141·6. The solutions are precipitated green by alkalies, but the precipitate dissolves in excess with a blue colour. Sulphuretted hydrogen gives a brown precipitate which does not dissolve. Zinc reduces the sulphate first to a brown liquid, and on boiling to metal. Before the blowpipe it gives yellow glasses, which turn blue on cooling, and upon charcoal with soda there is formed a yellowish green coating.—*Berichte der Deutsch. Chem. Gesell.*

ON THE NEW HYDROGEN LINES AND THE SUPPOSED DISSOCIATION OF CALCIUM.

By H. W. VOGEL.

According to the views hitherto prevalent, the spectrum of hydrogen consists essentially of four lines. In my photographs of Geissler tubes filled with hydrogen I obtained along with the four chief lines a great number of others, among which several in the violet and the ultraviolet where distinguished by their intensity and definite character. The photographs of the spectra were published in the *Monatsberichte der Akad. der Wissenschaft. Berlin* (1879, p. 550).

To show that these new lines pertain to hydrogen itself and not to any admixture of foreign gases, I repeatedly photographed the spectrum of electrolytic hydrogen, in my opinion chemically pure. I obtained the same lines as heretofore, and can no longer hesitate to ascribe them to hydrogen.

Amongst these new lines one is particularly remarkable for its brightness and for its coincidence with Fraunhofer's line H', generally attributed to calcium, to which body Fraunhofer's line H" also belongs. The existence of this conspicuous line, which is present in all my hydrogen spectra, and according to more recent measurements appears rather less refrangible than Fraunhofer's H', and

which I designate as the fifth main hydrogen line (Hd $_\epsilon$),* leads me to certain conclusions not, I believe, devoid of interest.

Lockyer, founding on the fact that the spectrum of calcium becomes modified at elevated temperatures, has conjectured that this body becomes dissociated at elevated temperatures into two elements, X and Y, to one of which the first H-line belongs, and the second to the other. He has not, however, hitherto succeeded in effecting this dissociation of calcium with terrestrial sources of heat.

He believes, however, that this takes place in the high temperature of the "white" fixed stars, which are regarded as the hottest. He depends upon an observation of Huggins, who has photographed the spectra of Sirius and Vega, and has ascertained that in them only the first of the two thick H-lines of the solar spectrum is present, the second being entirely wanting or scarcely visible.

I interpret this fact in another manner, and ascribe the solitary H' line, seen in the spectra of the fixed stars, not to calcium, but regard it as the fifth hydrogen line.

I am the more justified in this view, as the hydrogen lines are developed in a conspicuous manner in the spectra of the above stars, and appear broader and more intense than the hydrogen lines of the solar spectrum.

My opinion is further supported by the details of the observations on star spectra published by Huggins in No. 2 of the *Comptes Rendus* for 1880. He gives a list of the star lines in the violet and the ultra-violet according to wave-lengths. The first two of the 12 which he mentions are the known hydrogen lines, Hd $_\gamma$ and Hd δ; the following ones agree so manifestly with my new hydrogen lines, the wave-lengths of which I published eight months ago, that their identity can scarcely be doubted.

I have not obtained further, more refractive lines, as I worked with glass prisms, which absorb the ultra-violet light strongly. Huggins used quartz prisms and obtained six further lines. The striking coincidence of my hydogen lines with Huggins's star lines warrants the conjecture that the remaining lines in the spectrum of the white stars belongs to hydrogen.

There requires a further investigation with apparatus of greater dispersive power in order to decide if the new hydrogen lines are contained in the solar spectrum. The fifth line will be hard to recognise, as it is covered by the very broad adjacent calcium line, H'.

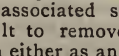
Lockyer refers to the observation of Young, according to which the H' Fraunhofer line was seen 25 times, but the H'' line 50 times "injected into the chromosphere, and explains this isolated appearance of the H' line (without H'') by the dissociation of calcium. On the contrary I take this line thus seen alone to be the fifth hydrogen line Hd $_\epsilon$.—*Berichte der Deutschen Chem. Gesellschaft.*

ON THE USE OF

THE SPECTROSCOPE IN DISCRIMINATING ANTHRACENS.

By BENJAMIN NICKELS, F.C.S., F.I.C.

In my last paper referring to this subject, I stated that the magnificent absorption spectra observed with yellow chrysen was due to an associated substance fusing at 280° C., extremely difficult to remove for examination, and "containing nitrogen either as an element of constitution or of a still further associated body unrecognised. I am now in receipt of a communication from the Continent, and from which I learn that the substance in question has already received the attention of Graebe, who ascribes to it a fusing-point of 330° C., and the following formula:—



* The author marks hydrogen as Hd to avoid confusion with Fraunhofer's H.

viewing it as a "phenylen naphthylenimid," or a carbazol containing the group phenylen and naphthylen as replacements. The compound was described by that chemist last year, but I am told no abstract of the paper has appeared in our English journals.

A very beautiful specimen of the preparation has been kindly sent to me, and which in appearance closely resembles that of my own, differing only in tint and degree of purity; it is of a deeper green colour, and higher fusing-point, and, examined spectroscopically, presents the superb and coincident absorption-bands.

104, Leadenhall Street, E.C.,
March 6, 1880.

SOME NEW AZO-COLOURS.

By JAMES H. STEBBINS, jun., B.S.

When I first began the study of the azo-compounds I selected as my starting-point the action of diazobenzol upon the amines, amides, and phenols, reserving the privilege of experimenting with the higher diazo-compounds at some future period.

The following compounds are the results of my experiments:—

Azobenzol-trinitro-oxybenzol, $C_6H_5N=NC_6H(NO_2)_3OH$.

This compound was obtained by treating an alcoholic solution of picric acid with an aqueous solution of one molecule of diazobenzol nitrate.

After standing a short time the liquid became filled with long brown needles. These had then to be filtered rapidly, as only a short contact with the mother-liquor was sufficient to decompose them. They were then washed several times with cold alcohol, and dried in the air-pump over sulphuric acid.

When dry they appear as long, brown, prismatic needles with a strong metallic lustre. They are very explosive, a temperature of about 70° C. being sufficient to explode them. The melting-point could not be obtained owing to this circumstance.

They are insoluble in cold, but slightly soluble in boiling water, under partial decomposition. On the other hand, they are readily dissolved in warm alcohol, with a pretty yellow colour.

The analysis of the above compound leads to the following result:—

	Theory.		Found.
C_{12}	144	43·21	43·33
H_7	7	2·10	2·59
N_5	70	21 02	20·93
O_7	112	33·67	—
	333	100·00	—

These figures prove the correctnsss of the assumed formula, viz., $C_6H_5-N=N-C_6H(NO_2)_3OH$.

Azobenzol-pyrogallol, $C_6H_5-N=N-C_6H_2(OH)_3$.

This was obtained by treating an alkaline solution of pyrogallol with an aqueous solution of 1 mol. of diazobenzol nitrate. Immediately a brick-red precipitate is formed, which increases on standing. It was then collected on a filter, washed with a little alcohol, and dried. It dissolves in glacial acetic acid and nitrobenzol, from which it crystallises in dark red-brown needles. An alcoholic solution of these dyes silk and wool of a pretty old-gold colour without mordants. The analyses gave the following results:—

	Theory. Anal. 1.		Found. Anal. 2.	
C_{12}	144	62·60	62·36	62·28
H_{10}	10	4·34	5·23	4·64
N_2	28	20·86	—	—
O_3	48	12·20	—	—
	230	100·00	—	—

These figures evidently lead to the following formula:—
$C_6H_5-N=N-C_6H_2(OH)_3$.

Azobenzol-oxycarboxyl-benzol,
$C_6H_5-N=N-C_6H_3\begin{matrix}OH\\COOH\end{matrix}$.

This pretty orange dye was obtained by the action of diazobenzol nitrate on an alkaline solution of salicylic acid. It crystallises in orange-red needles, which are insoluble in water, but easily soluble in alcohol or ether. If this compound be treated with strong sulphuric acid it dissolves, forming a sulpho-acid which, to me, has all the appearances of the compound obtained by P. Griess from diazosulphanilic and salicylic acids.

Azosulphoxylbenzol-phloroglucin.

This was produced by the action of diazosulphanilic acid on an alkaline solution of phloroglucin. A heavy orange precipitate is thus formed, which is collected on a filter, dissolved in water, and precipitated as a soda salt by means of common salt. The compound thus obtained has the appearance of an orange crystalline powder, and is easily soluble in water. The free acid may be obtained by treating a concentrated aqueous solution of the soda salt with an excess of strong hydrochloric acid. It crystallises in thin orange tablets with a beetle-green lustre.

Animal fibre is dyed a fine orange with these.

Azobenzol-diamido-toluol Nitrate.

This pretty orange dye-stuff is obtained by treating an aqueous solution of diazobenzol nitrate with a solution of alpha-toluylen-diamin, melting-point 99°. Immediately the mixture assumes an orange-red colour, and, after an hours' standing, the liquid becomes filled with fine red needles. These are then thrown on a filter and allowed to drain; they are then dissolved in boiling water, and the base is set free with ammonia in the form of a yellow-coloured crystalline precipitate. These crystals are then washed and dried at 100°. The analysis leads to the following formula:—$C_6H_5-N=N-C_6H_2(NH_2)_2CH_3$.

C_{13}	.. ..	68·35 per cent
H_{14}	.. ..	7·61 ,,
N_4	.. ..	24·60 ,,

The base unites readily with acids to form salts; but the best form of salt is the chloride, as it is by far the most easily soluble and convenient to handle.

If a concentrated solution of the chloride be treated with an aqueous solution of zinc chloride a heavy, crystalline, orange-red precipitate of the zinc double salt is formed. Platinic chloride produces a precipitate of beautiful crimson needles, which constitute the platinum salt.

If this dye be dissolved in strong H_2SO_4, and heated for a short time, and then thrown in cold water, a heavy precipitate is formed, which constitutes the sulpho-acid. This dissolves in water readily, but has a browner tinge than the previous dye. Reducing agents decolourise the solution, regenerating toluylen-diamin.

Diamido-azonaphthalen Hydrochlorate,
$C_{10}H_7N=N-C_{10}H_5(NH_2).2HCl$

I obtained this brown dye by the action of diazonaphthalen hydrochlorate in aqueous solution, on a solution of naphthalen diamin dissolved in alcohol. If a little of the solution be evaporated the colouring matter will crystallise out in long brown needles. These are insoluble in water, but quite readily soluble in alcohol. Strong sulphuric acid dissolves it with a fine blue colour. Reducing agents decolourise the solution.

Azobenzol-sulphocresol,
$C_6H_5-N=N-C_6H_2(HSO_3)OH.CH_3$.

If an alkaline solution of cresol-sulpho-acid be treated with an aqueous solution of diazobenzol nitrate the result is a deep orange-coloured oily liquid. If this be allowed to stand for a short time, and then be treated with an excess of hydrochloric acid; the acid by this means set free will, after a short time, crystallise in long brown needles with strong metallic lustre. These are quite soluble in alcohol—less so in hot water, to which they impart a fine orange colour.

I am now working on the higher diazo-compounds, and have already obtained a series of new colours, far surpassing the previous ones in beauty and durability, and will, on some future occasion, lay before you the results of my work.—*Journal of the American Chemical Society.*

COMPOUND PLATINATES AND A NEW PLATINO-POTASSIUM SALT.

By LUCIUS PITKIN.

When a solution of platinum tetrachloride is mixed with a solution of potassium bromide in some degree of concentration, a precipitate is formed which although resembling in many points the ordinary double chloride of platinum and potassium yet is of a much darker colour. The shade of colour depends largely on the rapidity of the precipitation, rapid precipitation in the cold forming a dark orange powder, while a slower formation favours the production of small reddish crystals. As will be seen further on, the amount of potassium bromide present influences the colour of crystal, as does also the presence of hydrochloric acid in greater or less amount.

Two formulæ can be given for the reaction mentioned above. In the first we may suppose the chlorine of the platinic chloride combines directly with the potassium forming a double chloride, while platinic bromide is left in solution: the latter now unites with a fresh portion of potassium and platinum.

I. $4KBr+3PtCl_4=2(2KCl,PtCl_4)+PtBr_42KBr+PtBr_4=$
$=2KBr,PtBr_4$.

In the second case, however, we may suppose a direct combination of the bromide with the chloride forming a salt with the composition $2KBr,PtCl_4$.

II. $2KBr+PtCl_4=2KBr,PtCl_4$.

It is obvious that whether a mechanical mixture of double chloride and bromide takes places in the proportion of two (2) to one (1), or whether a chloro-bromo-platinate of potassium is formed, the percentage of each constituent remains exactly the same.

In order to determine then whether a new salt of definite proportions has been formed, or whether we are dealing with a mixture, we must resort to the use of solvents of fractional crystallisation.

The percentage of platinum in both cases is 34·35, which was found to agree most closely with an analysis of the pulverulent precipitate formed by adding platinic chloride to potassium bromide in excess. In order to ascertain if hydrochloric acid would exercise a replacing power, and allow the formation of a double chloride, three determinations were made of precipitates produced under varying circumstances.

In the first determination 4 grms. of potassium bromide were dissolved in a minimum amount of water, 2 c.c. of strong hydrochloric acid added, then 0·500 grm. of PtCl in solution. A pulverulent precipitate was the result, 0·4175 grm. of which yielded 0·144 grm. of metallic platinum, or 34·49 per cent.

The determination of platinum was made in the usual way, *i.e.*, a known amount of the thoroughly dried salt was decomposed by heat, with the aid of oxalic acid, and, after being thoroughly washed, was dried and weighed in the state of spongy metal.

The conditions of the second determination were the same, except 1 c.c. of concentrated hydrochloric acid was used in place of the 2 c.c. of the previous experiment

0·3565 grm. of the precipitate gave 0·123 grm. of metallic platinum, which is equivalent to 34·47 per cent.

In the third determination no hydrochloric acid was used, and the resulting precipitate contained 34·1 per cent of platinum, 0·1444 grm. being obtained from 0·4236 grm. of the substance.

We see from this that hydrochloric acid has no effect on the chemical constitution of the precipitate, the average yield of platinum being 34·32 per cent against a theoretical 34·35 per cent.

But the acid produced one effect which is interesting to note: without changing the constitution it produced a change in the colour, which was not accidental or confined simply to these determinations, for a second trial fully confirmed the first; the change consists in the tint of the precipitate growing lighter in direct proportion to the amount of acid used. It being then proven that the precipitate was constant under variations in the amount of hydrochloric acid used, it remained to determine whether it were simply a mixture, or whether a new salt—not noted in any work on chemistry which I have consulted—had been formed.

The method chosen was fractional crystallisation, as offering the best results, for the separation, if a mixture, or for the confirmation of the definite character, if a new and constant salt. The result has been such as to leave no doubt but that a salt of the composition $2KBr.PtCl_4$ is formed under favourable conditions, while the investigation necessary to prove the fact has led to some interesting points in the relation of chloro-platinates to the bromo-platinates of potassium.

In order to crystallise successive crops a strong solution of potassium bromide was made, and platinic chloride in solution added, the bromide being in excess; by cautious evaporation five crops of crystals were obtained, which it was supposed would in the case of a mixture yield a successive difference in the ratio of platinum, or else prove the existence of chloro-bromo-platinate by exhibiting a constant percentage of platinum, and the percentage would be 34·35.

But neither result appeared, as the tabular view of the experiments will show, crops 1, 3, and 5 being selected for determination.

Experiment 1—Crop 1.

Amount ppt. used	0·5371
Amount platinum	0·1406
Percentage platinum..	26·1800

Exp. 2—Crop 3.

Amount ppt. used	0·3680
Amount platinum	0·0960
Percentage platinum..	26·1000

Exp. 3—Crop 5.

Amount ppt. used	0·2688
Amount platinum	0·0724
Percentage platinum..	26·9000

It will be seen that the crystallisation has shown no change in the composition of the five specimens; but what it has shown is this, that boiling a haloid platinate of potassium with a strong solution of potassium bromide insures the formation of a double bromide of platinum and potassium. The theoretical amount of Pt in $2KBr,PtBr_4$ = 26·3 per cent, while the average of the above gives 26·39 per cent of metallic platinum. Here also a curious colour change is apparent without change in chemical constitution, each successive crop becoming darker and darker. The first crystals were bright red. The second crystals were red. The third crystals were brownish red. The fourth crystals were dark brownish red. The fifth crystals were blackish red.

In order to put the question to a crucial test, as to whether the boiling with potassium bromide produces double bromides, some double chloride was formed in the usual way, re-washed with alcohol, and then treated with boiling KBr solution; on re-crystallisation and washing with alcohol it proved to be a double bromide yielding 26 per cent platinum, while the double chloride yields 40·6 per cent. A new set of crystals were made now by taking 2 grms. of $PtCl_4$, 0·1404 grm. of KBr, and making two solutions: upon pouring these together a copious precipitate appeared; this was filtered, washed with alcohol, and dissolved, and from its solution successive crops of crystals formed.

It will be seen that in this case little time was given for the full action of the bromide on the chloride; and if the tendency is to form first a double chloride, which is afterwards acted on by the bromide, no chance was afforded by the process.

The resulting crystals, three crops of which were separated, were all of the same tint, a rich bright yellow, and gave—

First crop, 38·3 per cent platinum.
Second crop, 38·0 per cent platinum.
Third crop, 39·0 per cent platinum.

The proportions used of the bromide and chloride were capable of forming the chloro-bromo-platinate if opportunity was given for full action and the platinic chloride were perfectly pure: it was of Merck's manufacture, and none remained to test as to purity.

For the final and decisive test, as to the existence of platinate of potassium in which bromine and chlorine are both united, I prepared my platinic chloride from spongy platinum, and afforded full opportunity for mutual reaction by boiling several hours.

The proceeding was as follows:—2000 grms. of platinic chloride were dissolved in 20 c.c. distilled water, and added to a solution of 1·404 grms. of potassium bromide in 50 c.c. water; the solution was then boiled for four hours, and finally evaporated slowly, and three crops of crystals recovered.

The crystals were all of the same tint, a rich dark orange, and gave uniform results in the determination of the amount of platinum contained.

Crop No. 1.

Amount used	1·0123
Pt found	0·3465
Percentage platinum..	34·2200

Crop No. 2.

Amount used	0·6311
Platinum found	0·2205
Percentage platinum..	34·7000

Crop No. 3.

Amount used	0·6479
Platinum found	0·2228
Percentage platinum..	34·3900

These percentages strike an average of 34·43 per cent, a variation of only 0·08 per cent from the theoretical composition of chloro-bromo-platinate of potassium, while their absolute identity in tint supply another strong reason for considering them as such.

To resume, then, in closing, the following facts may be taken as well established:—

First. The formation of a compound containing bromine when potassium bromide is used with platinic chloride.

Second. The conversion of chloro-platinates into double bromides by action of hot solution of potassium bromide.

Third. The variation in shade of colour, in regular gradation, of crystals separated out of boiling bromide solution, as also the colour effect of hydrochloric acid.

Fourth. The formation of a chloro-bromo-platinate, by suitable action of platinic chloride on potassium bromide, which salt is of an orange colour, and crystallises in fine octahedra.

In the commercial analysis of potassium compounds the amount is generally estimated by the weight of the dried double chloride or by the amount of metallic platinum contained in that salt. If the latter method is pursued no objection can be urged, as one (1) equivalent of platinum corresponds to two (2) of potassium, whether in the form of double chloride, bromide, iodide, or chlorobromo-platinate. But it is plain that no such relation exists between the amount of potassium and the salts mentioned.

If the weight of the precipitate is also known, it becomes an easy calculation to estimate the approximate amount of chloride and bromide present together, from the ratio between the dried precipitate and the platinum obtained from it.

Fresenius, in his "Quantitative Analysis," recommends treating salts of potassium other than chlorides with hydrochloric acid, and evaporating to dryness.

Rose proposes the use of chlorine water in the same way: the latter method decomposes the bromide better than the former, but is rendered unnecessary if a determination of the metallic platinum is made.—*The School of Mines Quarterly, Columbia College, New York.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

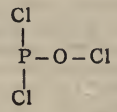
Thursday, March 4, 1880.

Mr. WARREN DE LA RUE, President, in the Chair.

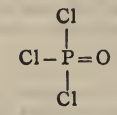
THE list of Officers as announced at the last meeting was read from the Chair. The following certificates were read for the first time:—A. E. Black, C. H. Gimingham, W. Regeater, W. Robinson, H. C. Stephens.

The PRESIDENT then called on Prof. THORPE to deliver his lecture, "*On the Relation between the Molecular Weights of Substances and their Specific Gravities when in the Liquid State.*"

The Lecturer said that he proposed to give the substance of the results of some work with which he had been engaged for the last four to five years. It consisted of a critical and experimental examination of Kopp's laws relating to specific volume. Many attempts had been made to trace a relation between the specific gravity and molecular weight of a liquid, but no definite conclusions were arrived at until Kopp published his well known memoirs, the principal reason of failure being that previous observers did not compare the liquids under comparable conditions. Kopp was the first observer who—by dividing the specific gravities of liquids, taken at the temperatures at which their vapour tensions are equal to the standard atmospheric pressure, *i.e.*, at their ordinary boiling-points, into their molecular weights—obtained certain comparable values which are known as specific volumes. If the specific gravities are referred to water at 4° C., these values represent the number of c.c. occupied by the relative molecular weights of the liquids expressed in grammes at their respective boiling-points under normal pressure. Thus, the specific volume of water is 18·8, *i.e.*, 18 grms. water at 100° occupy 18·8 c.c. The numbers so obtained were first shown by Kopp to exhibit certain definite relations which may be briefly indicated as follows:—(1) In many instances differences in specific volume are proportional to differences in corresponding chemical formulæ. Thus a difference of CH_2 in a homologous series corresponds to a difference of about 22 in the specific volume. (2) Isomeric and metameric liquids have, as a rule, the same specific volume: exceptions occur in certain sulphur and oxygen compounds. (3) The substitution of an atom of carbon for two of hydrogen makes no alteration in the specific volume of members of certain groups of organic liquids. It would seem to follow from Kopp's observations that the volume of a liquid formed by the union of two other liquids is equal to the sum of the specific volumes of its components. Another conclusion which Kopp states with caution is that members of the same family of elements possess identical specific volumes: thus the common value for Si, Ti, and Sn seems to be about 35; for P, As, and Sb about 27. On the basis of these conclusions Kopp was able to calculate certain fundamental values which are, as a rule, constant for each element. Thus carbon has always the value 11, hydrogen being 5·5. Certain exceptions, however, occur with oxygen and sulphur. Thus the specific volume of water being 18·8, and of hydrogen 11, we get as specific volume of O 7·8. In aldehyd, C_2H_4O, we have (C)22+(H)22=44; its specific volume is 56·2: thus the value for oxygen is 56·2−44=12·2, and so on for other substances. It appears that when oxygen is united to an element by both its affinities its specific volume is 12·2; when attached by only one it is 7·8. Sulphur has similarly two values, 28·6 and 22·6. Thus the constitution of such bodies as phosphoryl trichloride may be elucidated. If P is trivalent the constitution of this substance must be—



If pentavalent—



From determinations of the specific volume of $POCl_3$ it seems that the phosphorus is trivalent. The specific volume of nitrogen also seems to be variable; from Kopp's researches it has a value in the amines of 2·3; in cyanogen and certain nitro compounds of 17; and from recent researches of Ramsay its value seems to vary in different amines, and, moreover, has a distinct value in the pyridin series. Buff suggested, as the atomic value of an element is variable, its specific volume might be a function of that value: the evidence adduced is not, however, conclusive. There is no known reason why O, S, and N should alone possess variable specific volumes. Recently much interest has accrued to the question from the relations which have been shown to exist between the atomic weight and the chemical and physical characters of an element: probably the specific volume is a periodic function of the atomic weight. On reviewing the question, the following problems seemed to the author well worthy of solution:—(1) Has an element in combination an invariable specific volume? or may not the volume be modified by the number of the atoms of that element in the molecule? Is it quite independent of the general complexity of the molecule, or may not the specific volume of the molecule be a function of its weight? (2) Do the various members of a given family of elements possess identical specific volumes, or may not the volume be a function of the atomic weight? (3) Would a re-examination of the cases of the variable atomic values show that the specific volume of an element is a function of that value, as Buff supposes? (4) The hypotheses of Mendelejeff and Meyer indicate the need for additional and more exact determinations of the values for the specific volumes of the elements. (5) To multiply examples of the aid afforded by a knowledge of the specific volume of a compound in elucidating its constitution. The author then drew up a scheme of work involving the determination of the specific volumes of fifty-two liquids, inorganic and organic, those liquids being preferred which boiled below 200°, and which could, without great difficulty, be obtained pure and in large quantity. The results of the observations determine the specific volumes of the following 17 elements:—H, F, Cl, Br, I, O, S, Cr, N, P, V, As, Sb, C, Si, Ti, Sn.

The author then gave a short account of the methods used to prepare some of the liquids and the care taken to ensure and ascertain their purity. Great reliance was placed on vapour-density determinations; a modified form of Hofmann's apparatus was employed. The vapour required to heat the liquid was introduced from below, the vapour-density tube having no etched scale, to prevent the risk of cracking, only one mark being made on the tube, readings being taken by a separate movable brass scale divided into millimetres. The whole mass of mercury within the tube is uniformly heated to a known temperature: 300 c.c. of mercury and 150 c.c. of liquid (for the boiler) are required to work the apparatus. To determine the specific volumes the author has adopted the principle used by Kopp—(1) To determine the specific gravity of the liquid at some convenient temperature; (2) to ascertain its boiling-point with the utmost exactitude; (3) to determine with great care its rate of expansion, say between 0° and the boiling-point. In this way, at all events, a number of accurate and important physical data would be put on record, even if the main object of the investigation were not attained. The author then described the apparatus and methods used in these three determinations. Thermometers—two sets were used, one of three by Casella, from −9° to 160°, graduated into tenths, each tenth being about 1 m.m. The second set was by Geissler; it also consisted of three, with a range from −14° to 170°, graduated into tenths, each degree being about 6 m.m. These were carefully compared with Kew standards, and calibrated. Careful determinations of the fixed points of the thermometers were made, and their variations plotted in curves. The Dilatometers were constructed of flint glass; the stem of each instrument was about 50 c.m. long, graduated into millimetres; the bulbs contained 2 to 4 c.c. Each bulb was heated and cooled several hundred times before being used: no important change of capacity was observed during the determinations. The dilatometers were calibrated by the introduction or removal of known weights of mercury. Air was removed by exhaustion with a Sprengel pump and subsequent introduction of pure warm mercury by a capillary tube which reached to the bulb. Nine dilatometers were used. As the thermometers used were long, great care was taken in obtaining a correct expression for the correction due to the portion of the stem not surrounded by vapour. In the formula $\delta(t-t')n$ the author has taken for δ (apparent expansion of glass for 1°) a mean value of 0·000143, and gives a table of corrections calculated on this value. The specific gravity bottles held 4 to 20 c.c., and were fitted with ground glass stoppers. All weighings were made by the method of vibrations, and are reduced to a vacuum. The author then described the arrangement adopted for filling the dilatometers with the liquids, originally devised specially for liquids altered by exposure to air, but found so convenient that it was adopted in all cases. The method used in determining the expansion was then given. Two forms of apparatus were employed, one for temperatures below 65°, filled with water, heated by steam, the other filled with oil, heated by a lamp; the capacity of each bath was over 20 litres. Up to 25° the temperature could be obtained absolutely constant, but above, two series of readings were taken, one with the temperature rising very slowly, the other with the temperature falling. In reducing the observations the author largely availed himself of the arithmometer of Thomas (de Colmar), without which the labours of the calculations would have been insuperable. Some experiments proved that Matthiessen's objection to the dilatometrical method—viz., that it gave uniformly low rates of expansion—was unfounded. The author arrived at the following conclusions:—That a difference of CH_2 in a homologous series does correspond to a difference of about 22 in the specific volume. That carbon has a constant specific volume of 11 and hydrogen of 5·5: there is no valid reason for accepting Buff's hypothesis that the specific volume is a function of the atomic value of an element. As far as sulphur and oxygen are concerned the author has obtained results identical with those of Kopp. The inference of Kopp that members of the same family have the same specific volume does not appear to be well founded. Lastly, it seems that the specific volume is a periodic function of the atomic weight.

The President then proposed a vote of thanks to Prof. Thorpe for his lecture, and the able way in which he had explained the results of his elaborate investigations.

Dr. Wright asked if any experiments had been made with chloric or perchloric acid in order to determine the quantivalence of chlorine in these bodies.

Dr. Armstrong commented on the difficulties in accepting the view of the triad nature of P on $POCl_3$ when the reactions of the body were taken into consideration, especially as Dr. Thorpe had himself prepared a pentafluoride.

Dr. Japp pointed out the danger of using the specific volume as an evidence of the atomicity of an element too freely. Thus, for instance, according to the evidence derived from a determination of specific volume, the two atoms of S in CS_2 had different values; one 28·6, the other 22·6.

Dr. Gladstone asked if Prof. Thorpe had compared the specific volume in any way with the refractive energy.

Prof. Thorpe, in reply, said that he had no intention of experimenting with chloric or perchloric acid until he had finished all the observations he wished to make with his apparatus. He admitted that there were difficulties in assuming that phosphorus was a triad in $POCl_3$, but thought that there was evidence to support that view; also that there was some physical evidence that the two atoms of sulphur were not identical in carbon disulphide. He had not compared the specific volume with the refractive index.

The thanks of the meeting were given to Prof. Thorpe for his lecture.

The apparatus for determining the vapour-density, and the arithmometer were exhibited.

The Society then adjourned to March 18th, when Prof. Tidy will read a paper on River Water.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, March 1, 1880.

Edward Frankland, D.C.L., Ph.D., F.R.S., Manager, in the Chair.

Foster Fitz-Gerald Arbuthnot; Richard Claude Belt; Shelford Bidwell, M.A., LL.B.; James Crichton-Browne, M.D., LL.D., F.R.S.E.; Henry G. Bunbury; Miss Isabella Clerk; Vicat Cole, A.R.A.; Alfred Kingsford Coles; Frederick Thomas Jennings; Alfred Lloyd, B.A., F.R.G.S.; William Mansell MacCulloch, M.D.; Miss Louisa Millar; Miss Isabella Milne: Major H. C. Roberts; Isaac Seligman; Mrs. Isaac Seligman, were elected Members of the Royal Institution.

The presents received since the last meeting were laid on the table, and the thanks of the Members returned for for the same.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 6, February 9, 1880.

Virulent Maladies, and the so-called Cholera of Fowls.—M. Pasteur.—A very long account of the disease in question, and of the experiments undertaken to elucidate its nature.

Spectrometric Measurement of High Temperatures.—A. Crova.—The account of the spectro-pyrometer devised by the author for this purpose, and of the method of its use, does not admit of abstraction.

Chemiker Zeitung.
No. 3, 1880.

Danger to Fish from the Liquid Refuse of Manufactures (Bleach Works).—Dr. Weigelt.—The author has made experiments on trout. Free chlorine to the extent of 0·005 grm. per litre killed in a few minutes trout of 5 to 20 grms. in weight. On longer exposure, solutions containing even 0·0002 grm. were found fatal to small fishes, *i.e.*, free chlorine appeared destructive even to the very limit of its detectability. Soda-lye is much less injurious. In solutions containing from 3 to 0·1 grm. of crystalline soda per litre, trout were able to remain from ten to forty-five minutes without injury. Sulphuric acid is far less pernicious than hydrochloric acid. Neutral salts, such as calcium and sodium chloride, had no injurious action in the proportion of 5 parts in the thousand. It is doubtful in how far these results are applicable to other species of fish.

Chemisches Central-blatt.
No. 1, 1880.

New Chemical Photometer.—J. M. Eder.—The author determines the ultra-violet rays in daylight by means of mercury oxalate, and investigates the photo-chemistry of mercuric chloride. He uses a mixture of the latter salt with ammonium oxalate.—*Wiener Anzeiger*, 1879, p. 240.

Spectra of Hydrogen, Mercury, and Nitrogen.—H. W. Vogel.—*Berlin Monatsber.*, 1879, p. 586.

Volumetric Equivalence of Oxygen and Chlorine.—A. W. Hofmann.—A full description of arrangement for a lecture experiment.—*Berlin Monatsber.*, 1879, 673.

The Action of Light and the Function of Chlorophyll in Plants.—M. Pringsheim.—The author has studied plants under the influence of intensified light. He points out that plants growing under coloured glasses or behind coloured liquids are, as compared with their normal conditions, in the dark. Chlorophyll is rapidly destroyed by intensified light of all colours, but much more rapidly in the blue than in the red ray. This change appears independent of heat, but does not take place in the absence of oxygen. The presence or absence of carbonic acid is indifferent.

No. 2, January 14, 1880.

Solubility of Mixtures of Sodium and Potassium Chlorides.—J. Schönach.—A determination of the solubility of such mixtures at all temperatures from 0° to 100°. —*Wiener Anz.*, 1879, 236.

Compounds from Animal Tar.—H. Weidel and J. Herzig.—By oxidising the bases of bone-tar, which boil between 150° and 170°, the authors obtained two well-characterised, nitrogenous, bibasic, isomeric acids, the isoquinchomeronic and the lutidinic, $C_7H_5NO_4$.

No. 3, January 21, 1880.

Decomposition of Alkaline Tri-sulpho-carbonates in the Animal System.—L. Lewin.—The poisonous properties of these compounds are ascribed to the liberation of hydrogen and carbon sulphides under the action of carbonic acid.—*Virchow's Archiv.*, 76, 452.

Carbonic Oxide as an Agent for the Preservation of Meat.—H. Nietner and K. Zimmermann.—The authors have repeated the experiments of Hunt and Gamgee, but with a negative result. Carbonic oxide showed no power to prevent putrefaction.

Examination of the Earth of a Church-yard for Products of Animal Decomposition.—E. Reichardt.—The soil in question, after a period of disuse of 30 years, still gave off animal oil when submitted to destructive distillation.—*Arch. Pharm.*, xv., 421.

Qualitative and Quantitative Determination of Albumen in Urine.—S. P. Ilimow.—The author acidifies the urine if necessary with acid phosphate of soda. It is then allowed to settle, cooled, and filtered for the removal of mucus and urates. It is then placed in a test-glass and mixed with dilute carbonic acid (1 part acid to 20 water). If no turbidity arises, even on slight warming, the absence of albumen may be assumed. If albumen is present, even in very small quantity, turbidity ensues, followed by a flocculent deposit.

Studies on the Thomas-Gilchrist Process.—Jos. v. Ehrenwerth.—From the *Oesterr. Zeitung*, xxvii., 599, 619, 629.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
No. 18.

Chemical Cause of the Poisonous Character of Arsenic.—C. Binz and H. Schulz.—The authors consider that the poisonous action of arsenic depends on its easy conversion and re-conversion within the organism from the higher to the lower stage of oxidation, whereby the tissues are destroyed owing to the violent vibration of the atoms of oxygen. For the same reason the other members of the nitrogen group are also poisonous.

Reply to F. Seelheim's Criticism on the Chlorine Experiments.—Victor Meyer.—See Chemical News, vol. xli., p. 219.

Determination of the Densities of Vapours which Attack Porcelain at a Red Heat.—Victor Meyer and H. Züblin.—The authors describe the construction of a platinum apparatus to be used instead of porcelain.

Attempt at the Preparation of Di-methyl-phenyl-glycocoll or Phenyl-betain.—J. Zimmermann.—An equivalent of mono-chloracetic acid was digested along with two equivalents of di-methyl-anilin, dissolved in ether. The ultimate product of the reaction is the hydrochlorate of a phenyl-betain, $C_{10}H_{14}O_2ClN$.

Halogen Derivatives of Æthan and Æthylen.—J. Denzel.—The following derivatives have been examined: Chlor-penta-brom-æthan, α-dichlor-tetra-brom-ethan, tetra-brom-ethan, penta- and hexa-brom-ethan. Several attempts at the preparation of unsymmetrical tri-brom-ethan proved unsuccessful.

Reactions of Ethyl-amin.—H. Kœhler.—Not adapted for abstraction.

Product of the Action of Ferric Chloride upon Ortho-diamido-benzol.—C. Rudolph.—The product is the hydrochlorate of a new base, $C_{24}H_{18}N_6O$.

Further Contributions to a Knowledge of Acetylen-dicarbonic Acids.—E. Bandrowski.—The author examines the copper salt of the above acid, also di-brom-acetylen-dicarbonic acid with its silver and lead salts.

Further Particulars on Pittacal and Eupittonic Acid.—A. W. Hofmann.—The question is raised whether eupittonic acid is formed from 2 mols. pyrogallic acid and 1 mol. methyl-pyrogallic ether, or if 1 mol. pyrogallic acid and 2 mols. methyl-pyrogallic ether have taken part in its formation. The author further examines the salts of eupittonic acid, its acid derivatives, its alcohol derivatives, and ethyl-ether, and iodine compound, and its behaviour with water.

Determination of Chromium.—Theodor Wilm.—Already given at some length.

Action of Hypochlorous Acid upon Acrylic Acid.—P. Melikoff.—A preliminary communication.

Action of Chlorine upon Naphthalin-α-sulphon-Chloride and γ-tri-chlor-naphthalin.—Oscar Widmann.—An account of the tetra-chloride of naphthalin-α-sulphon-chloride, of dichlor-naphthalin-α-sulphon-chloride, and γ-trichlor-naphthalin.

Dichlor-naphthalin-α-sulphonic Acid and its Salts.—O. Widmann.—The formula of the acid is—

$$C_{10}H_5Cl_2SO_2OH.$$

Its potassium, sodium, silver, barium, calcium, lead, and zinc salts, and its amide are here described.

Action of Hydro-Ferro- and Ferri-cyanic Acids upon Amines.—L. J. Eisenberg.—The author has obtained a hydro-ferrocyanate of aniline as a white crystalline salt, and has been similarly successful with ortho- and meta-toluydin, acetamid, brom-anilin, naphthylamin, &c.

On Tungsten Bronze.—J. Philipp and P. Schwebel.—This alloy, which is not perceptibly attacked in the wet way by alkalies nor by any acid except the fluoric, is decomposed if heated to boiling in a sealed tube along with a solution of silver acetate.

Toluylen-di-amins.—R. Nietzki.—The di-amins, when perfectly pure, may be easily recognised by their behaviour with oxidising agents. Whilst the ortho compounds deposit intensely coloured crystalline precipitates of a metallic lustre, the para and meta compounds display no such phenomena, and are characterised by the absence of the quinon reaction.

Hydroxylation by Direct Oxidation.—R. Meyer and A. Baur.—Not adapted for abstraction.

Constitution of Di-brom-ethylen.—E. Demole.—Not suitable for abstraction.

MISCELLANEOUS.

Royal Institution.—The following arrangements have just been made for the lectures after Easter:—Tuesdays—Prof. Huxley, Two Lectures on Dogs, and the Problems connected with them; Mr. Robert H. Scott, F.R.S., Four Lectures on Wind and Weather; Mr. John Fiske, Three Lectures on American Political Ideas from the standpoint of Universal History. Thursdays—Prof. Tyndall, Six Lectures on Light as a Mode of Motion; Mr. T. W. Rhys Davids, Three Lectures on the Sacred Books of the Early Buddhists. Saturdays—Mr. James Sully, Three Lectures on Art and Vision; Prof. Henry Morley, Five Lectures on the Dramatists before Shakespeare, from the Origin of the English Drama to the year of the Death of Marlowe (1593). The Friday evening meetings will be resumed on April 9th, Prof. Huxley on the "Coming of Age of the 'Origin of Species.'" Succeeding discourses will probably be given by M. Ernest Renan, Mr. W. H. Pollock, Mr. W. Spottiswoode, Mr. G. J. Romanes, Lord Reay, Mr. H. H. Statham and Mr. Francis Hueffer.

MEETINGS FOR THE WEEK.

SATURDAY, 13th.—Physical, 3. "Note on a New Source of Electricity," Prof. W. F. Barrett. "On the Surfusion of Certain Metals," W. Chandler Roberts.
MONDAY, 15th.—London Institution, 5.
—— Medical, 8.30.
TUESDAY, 16th.—Royal Institution, 3. Prof. Schäfer, "Physiology of Muscle."
—— Civil Engineers, 8.
—— Zoological, 8.30.
—— Society of Arts, 8. Captain C. E. Foot, "Transport and Trading Centres for Eastern Equatorial Africa.
WEDNESDAY, 17th.—Society of Arts, 8. W. Herbert Singer, "The Art of the Silversmith."
—— Meteorological, 7.
THURSDAY, 18th.—Royal Institution, 3. Prof. Dewar, "Chemical Progress."
—— Zoological, 4.
—— London Institution, 7.
—— Royal, 8.30.
—— Chemical, 8. "On River Water," Prof. Tidy.
FRIDAY, 19th.—Royal Institution, 8. Prof. Tyndall, "Goethe's Farbenlehre (Theory of Colours), 9.
SATURDAY, 20th.—Royal Institution, 3. Mr. Saintsbury, "Dryden and his Period."

NOTES AND QUERIES.

Separating Starch from Maize.—Can any of your readers inform me of the best process for separating starch from maize and the makers of the necessary plant?—J. C. O.

KING EDWARD'S SCHOOL, BIRMINGHAM.

A SCIENCE MASTER will shortly be WANTED in the MIDDLE SCHOOL of this Foundation. Commencing Salary, £250.

Applications, stating experience, with recent testimonials enclosed, should be sent in not later than March 25th, 1880, to the Secretary, King Edward's School, Birmingham, from whom further particulars may be obtained.

King Edward's School, Birmingham,
28th February, 1880.

YOUNG'S PARAFFIN LIGHT & MINERAL OIL CO., LIMITED.

The Directors of this Company are prepared to receive TENDERS for the supply of the GENERAL STORES required at their ADDIEWELL, BATHGATE, and BIRMINGHAM WORKS, and also at all their PITS, for the YEAR ENDING 30th APRIL, 1881, as under:—

Class No.		Class No.	
1.	Bolts, Nuts, and Rivets	23.	Lamp Burners, &c.
45.	Brass, &c.	24.	Lamp Founts and Hand Lamps
2.	Bricks, Clay, &c.	27.	Nails, Screws, &c.
4.	Candle Boxes	32.	Reflectors
5.	Canvas	29.	Ropes, &c.
6.	Cast Iron Castings	30.	Shades, Moons, &c.
7.	Chemical Apparatus	31.	Shives
8.	Cloths, Plaiding, &c.	39.	Shovels
10.	Corks	37	Timber
16.	Drysalteries	33.	Tin, Lead, &c., for Chemical Works
17.	Gas and Water Fittings	46.	Tin, Lead, &c., for Lamp Work
18.	Glass Chimneys	40.	Tools
19.	Grease, Soap, and Tallow	35.	Wicks
20.	Gun Metal	41.	Wire Ropes
21.	Hardware and Sundries		
22.	India Rubber, &c.		
44.	Japanning and Bronzing Materials.		

Detailed Specifications and Forms of Tender, and any other necessary information, may be obtained, on and after Wednesday, 10th current, at the Company's Registered Office, 7, West George Street, Glasgow.

Patterns of the General Stores may be seen at the Company's Addiewell Works, near Westcalder; and Patterns of Lamp Fittings at their Lochrin Works, Edinburgh.

Tenders endorsed "Tender for Stores," to be lodged with the undersigned on or before Wednesday, 24th current.

The Directors do not bind themselves to accept the lowest or any offer.

JOHN FYFE, General Manager.

Merchants' House Buildings,
7, West George Street,
Glasgow, 8th March, 1880.

TO CHEMICAL, GUM, STARCH, AND OTHER MANUFACTURERS.

To be Sold, by Private Contract, a Freehold Works, situated within 3 miles of Manchester, together with the first-class Machinery, Plant, Steam Engines, Boiler, &c. Two-thirds of the purchase money can, if required, remain on mortgage.—Apply to Mr. J. A. Harrison, Accountant, 13, Norfolk Street, Manchester.

Astronomical Clock for Sale, admirably suited as a Regulator in a Nobleman's or Gentleman's Mansion. The movement is of the finest quality, with compensation pendulum composed of rods of platinum and silver, with stone knife-edge suspension and agate pallats. Made for late proprietor for scientific purposes, and is an excellent timekeeper. Cost upwards of £100.—Apply J. C., Craigforth House, Stirling, N.B.

FACTORY WANTED in the neighbourhood of Chemical or Alkali Works in Lancashire; the Lease of a small Factory with boiler preferred, suitable for a Benzine Refinery.—Offers, containing full particulars (marked "Factory"), to Mr. Charles J. Cross, Brentford, Middlesex.

Wanted to Purchase an Air-Pump for working a Filter-Press.—Reply, X. Y. Z., J. Burbidge and Co., Advertising Agents, 62, Moorgate Street, E.C.

GREENBANK ALKALI WORKS COMPANY (LIMITED), ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{8}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{1}{200}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application. Orders for small quantities executed for Cash against Invoice.

NOTICE.

It having come to the knowledge of the BADISCHE ANILIN AND SODA FABRIK, of Stuttgart and Ludwigshafen on Rhine, that their Dyes numbered and patented as follows, viz.:—

Acid Magenta S,	numbered	3731,	and patented	8th October, 1877.
Acid Maroon S,	„	3731,	„ „	8th October, 1877.
Methylene Blue (Marine Blues),	„	3751,	„ „	9th October, 1877.
Fast Red	„	786,	„ „	25th February, 1878.

are being used and dealt in by persons who have not obtained the same from the Badische Anilin and Soda Fabrik, or their duly Authorised Agents,

NOTICE IS HEREBY GIVEN that the Badische Anilin and Soda Fabrik are the Sole and only Patentees for the said Dyes, and legal proceedings will be at once instituted against all persons found manufacturing, dealing in, or using the same, or having them in their possession, unless the packages or tins bear the patent labels and trade-mark of the Badische Anilin and Soda Fabrik.

All persons supplying to the Badische Anilin and Soda Fabrik, or to Messrs. Schott, Segner, and Co., of 4, Charlotte Street, Manchester, full proof of any infringement of the said Patents of the Badische Anilin and Soda Fabrik will be suitably rewarded.

Dated this 1st day of March, 1880.

(Signed) SALE, SEDDON, HILTON, and LORD, Solicitors, Booth Street, Manchester.

TO DYERS AND CAPITALISTS.

TO BE DISPOSED OF, in one of the Midland County Towns, in consequence of the ill-health of the Proprietor, an OLD ESTABLISHED and EXTENSIVE BUSINESS, with several Branches, in GARMENT DYEING and CLEANING. The Purchase Money, including Goodwill and Fixtures, would amount to about £7000, the Stock-in-Trade being taken by valuation. The FREEHOLD PREMISES, on which the principal business is carried on, could be Sold or Rented at the option of the purchaser.—Apply by letter to "Tintoretto," care of Messrs. SCRIVENER, GILL, and Co., 40, New Bridge Street, Ludgate Circus, London, E.C.

WILLIAM AND WILLIAM T. FIELD,

MANUFACTURERS of the Celebrated STAFFORDSHIRE BLUE BRICKS, specially adapted for Chemical Plant, *i.e.*, Acid Towers, &c. Also all other kinds of Best Staffordshire Blue Bricks, Pavings, Plynths, Splays, Copings, &c. &c. Prices and samples on Application.

TESTIMONIAL.

"We have used the Blue Staffordshire Brick for Sulphuric Acid Towers, &c., manufactured by Messrs. Field, for the last fifteen years, during which time they have given great satisfaction. We recommend them to the Chemical Trade, believing there is nothing better in the market."—(Signed) WILLIAM HUNT and SONS, Lea Brook Alkali Works, near Wednesbury, Staffordshire, February, 1878.

TOLL END BRICK-WORKS, TIPTON, STAFFORDSHIRE.

TOWNSON & MERCER,

89, Bishopsgate Street Within, LONDON.

Wholesale and Export Dealers and Manufacturers of

CHEMICAL & SCIENTIFIC APPARATUS PURE CHEMICALS, &c.,

For Analysis and the general Laboratory Use of Manufacturers and Professors of Universities, Schools, Mines, &c.

Now ready,

TOWNSON & MERCER'S COMPLETE CATALOGUE of Chemical and Scientific Instruments, Pure Chemicals &c. Demy 8vo. Illustrated with upwards of 800 Woodcuts. Price 2s. 6d. post free.

S. A. SADLER,

CLEVELAND CHEMICAL WORKS, MIDDLESBROUGH

Newfall Tar Works, Carlton; Ammonia Works, Stockton-on-Tees; and Stamshaw Chemical Works, Portsmouth.

And also of the Furness Tar Products Co., Ulverston.

London Office:—85, GRACECHURCH STREET.

Manufacturer of Benzole, Toluole, Xylol, Solvent and Burning Naphthas, Carbolic Acid and Disinfecting Powder, Refined Anthracene Naphthaline, Black Varnish, Refined Tar, Crude Liquid Ammonia, Coal-Tar, Pitch, Creosote, Grease, Sulphate of Ammonia, Pyroligneous Acid, Acetate of Lime, Wood Naphtha, Charcoal, &c., &c.

S. A. S. is always a buyer of Coal-Tar Naphthas, Crude Anthracen and all Tar Products.

All communications to be addressed to the offices at Middlesbrough

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

THE SPRENGEL AIR-PUMP.

GIMINGHAM'S IMPROVED.

WITH MULTIPLE FALL-TUBES and every recent improvement, including McLeod's Gauge, Barometer Gauge, Radiometer, terminals for testing non-conductivity of the vacuum, &c., &c.

L. Casella having arranged with Mr. Gimingham for the sole manufacture of these pumps is prepared to supply them either in their simple form or with all or any of the accessories. Mr. Gimingham has engaged to examine each instrument, in order that no imperfect instrument may be sent away.

CROOKES'S RADIANT MATTER TUBES.—L. Casella has also the pleasure of stating that he is now able to supply the highly exhausted tubes illustrating Mr. Crookes's beautiful experiments on Radiant Matter, and guarantee their excellence, as each will be sent to Mr. Gimingham for examination before going out.

L. CASELLA, 147, HOLBORN BARS, LONDON, E.C.

THE CHEMICAL NEWS.

VOL. XLI. No. 1060.

THE PERIODIC LAW OF THE CHEMICAL ELEMENTS.

By D. MENDELEEF.

(Concluded from page 114.)

OXYGEN combines with the atoms of each element R, in one or more of the following manners:—

R_2O, RO, R_2O_3, RO_2, R_2O_5, RO_3, R_2O_7, and RO_4.

We often obtain other lower forms of combination, such as R_4O, although in the cases of all the known elements higher forms have been observed. H_2 and O, judging from the constitution of water, are equal between themselves; if so, the first four lower compounds of oxygen are also equivalent to the forms of combination of hydrogen,

$$RH, RH_2, RH_3, RH_4.$$

As the number of equivalents of hydrogen and oxygen which can be fixed by one elementary atom does not surpass eight in all the elements which give RO_4 do not form compounds with hydrogen; the elements which give R_2O_7 give also RH, and those which give RO_3 give also RH_2; those which give R_2O_5 give RH_3, and those which give RO_2 give RH_4. The elements corresponding to the highest form R_2O_3 have not as yet given any compounds with hydrogen, because such a form of combination RH_5 as it would require, does not exist. Therefore the aptitude of elements to combine with hydrogen diminishes when their aptitude for combining with oxygen increases, and *vice versa*; the highest forms or limits of these compounds are RO_4 and RH_4, RH_4 corresponding according to the equivalent of water to the oxygen compound, RO_2.

The formation of complex saline compounds with oxygen is determined by the forms of the simple oxygen compounds; for example, it must be admitted that in the hydrates O is represented by equivalent quantities of $(HO)_2$ or H_2. Therefore, from SO_2 is formed $SO_2(OH)_2$, $SO_2H(OH)$, and SO_2H_2. From CO_2 is derived $CO(OH)_2$, $COH(OH)$, and COH_2. The other phenomena of substitution of this kind would take us too far. Some explain themselves, and I hope to discuss the others, later on, in a memoir developed on molecular combinations. The lower forms of combination are capable of being transformed into the highest forms, either by direct or indirect means. If the highest form that an element can give is RX_n, a given form RX_{n-m} can change into the limit form RX_n by the absorption of X_m, or of an equivalent quantity of other substances; that is easily understood without any further explanation.

The limit compounds of *chlorine*, or in general the *haloid* compounds, correspond to the compounds of oxygen

$$(RO_2-RCl_4;\ R_2O_3-RCl_3;\ RO-RCl_2);$$

they are often met with in forms far removed from the limit, and then they often correspond to the hydrogen compounds. They have never higher forms than the oxygen compounds. For example, in the case of Te, $TeCl_6$ corresponding to TeO_3 does not exist, but $TeCl_4$ corresponding to TeO_2 does. In the case of I, there is not ICl_7 corresponding to I_2O_7, but there is ICl_5, corresponding to I_2O_5. Again, taking As, there is no $AsCl_5$ corresponding to As_2O_5, but $AsCl_3$, corresponding to As_2O_3. In general, chlorine, like *oxygen*, often gives, besides the higher forms corresponding to the oxygen compounds, some lower forms.

The aptitude of several (but not all) elements, to form different forms of combination, is not expressed completely, either in the hydrogen compounds or in the highest forms of oxygen compounds, above all when a compound is composed of more than two elements. Entire molecules can combine one with the other and produce higher forms; both polymeric and so-called molecular compounds. As far as concerns Si, the form SiX_4 (corresponding to SiH_4, to SiO_2, to $SiCl_4$) does not show the limit to the compounds which this body can form. For Si does not only give SiO_2, but also SiO_{2n}, SiO_2, SiF_42HF, &c. Pt does not only give PtO_2, $PtCl_4$, or generally PtX_4 and PtX_2, but also PtX_4nA; A here means an entire molecule, and n, in most cases, is a whole number. For example:—

$$PtCl_42RCl,\ PtCl_48H_2O,\ PtCl_42HCl6H_2O,\ PtX_22NH_3,$$
$$PtX_24NH_3,\ PtCy_22HCy5H_2O,\ PtCy_2MgCy_2,\ 7H_2O,\ \&c.$$

Some of these forms of compounds are very stable, lend themselves to double decompositions, and are met with in many elements; such is the form RH_2X_6 for the elements which give RO_2 (X means a haloid or a haloid residue). For example:—

$$SiH_2F_6,\ PtK_2Cl_6,\ TeK_2Cl_6,\ ZrK_2(SO_3)_3.$$

These forms of combination serve to characterise the elements and their forms (for example, the form of alum, the form of several salts, RSO_47H_2O, $RK_2(SO_4)_26H_2O$, &c.). They therefore merit a comparative examination as exact as all the other forms with which they have no essential difference.

I do not pretend to erect, from the considerations that I have here set forth, a definite system. I know that many improvements and additions are still necessary, but I believe that the direction indicated and followed in this memoir will lead to the end desired by chemists more easily than any other will. Bold hypotheses have a peculiar attraction for us; they often cause a momentary progress; but more often they lead to inexact conclusions, and they themselves fall into disuse, above all if they are not built upon philosophical laws, for it is to the discovery of such laws that all scientific efforts should tend. I have endeavoured in the preceding developments to find support on the laws of substitution, on those of limits, as well as on the periodic law, and I believe that these laws should be taken as the basis of all generalisations on the forms of combination of the elements.

Independently of all that I have just said, I will add another observation and an example which clear my ideas on this subject in its essential parts. Two facts are necessary to actually identify an element; they are found by observation, by experience, and by comparisons. These are the atomic weight and the atomicity. The periodic law, in bringing to light the mutual dependence of these two values, at the same time affords us the means of determining one by the other; therefore, if the hypothesis of the atomicity of the elements determines the forms of chemical compounds, the periodic law does the same; but the latter goes still further, for it determines at the same time such forms of oxidation that the above-mentioned hypothesis neglected.

Boron and *Aluminium*, judging by their atomic weights, are analogues, and ought to give analogous compounds. Such is really the case, for they give oxides B_2O_3 and Al_2O_3: these oxides are the only ones formed by boron and aluminium. The hydrogenated compounds BH_5 and AlH_5 possible for these elements do not exist, for the general formula for the compounds of B and Al corresponds to RX_3. The form RX_5 is not represented in the isolated condition even in the hydrates; these last correspond to $R(OH)_3$. However, in consideration of the aptitude for more uncommon compounds, bodies composed according to the formula RX_5 are possible. Such bodies do in reality exist; they have been considered up to the present as being molecular compounds; for example, BHF_4. We can say that ordinary octahedric borax, $Na_2B_4O_75H_2O$ or $NaB_2H_5O_6$, answers by its composition to the form B_2O_3; that is to say, that this borax would be $B_2(OH)_5(ONa)$;

here again, then, the form BX_3 is preserved. As to the faculty which borax possesses of absorbing more water of crystallisation and being transformed into prismatic borax, $Na_2B_4O_7 10H_2O$, it is explained not only by the property which is peculiar to boron (of forming compounds like BX_5), but also by the property possessed by Na, of forming $Na(OH)3H_2O = NaH_7O_4$ independently of Na(OH). The aptitude of the form BX_3 to change into BX_5 is again shown by the reunion of BCl_3 with other chloranhydrides. H. Gustavson prepared not long ago, in our laboratory, a compound BCl_3POCl_3, perfectly crystallised. We know that aluminium possesses the same property, for it not only gives $AlCl_3NaCl$ and $AlCl_3POCl_3$, but also $AlF_3,3NaF$. I see in this property a reason for admitting the existence of combinations of several molecules, either of $AlCl_3$ or of polymers. The composition—

$$\left.\begin{matrix}AlCl_3\\AlCl_3\end{matrix}\right\} \text{ corresponds to } \left.\begin{matrix}AlCl_3\\POCl_3\end{matrix}\right\}, \text{ or to } \left.\begin{matrix}BF\\HF\end{matrix}\right\}.$$

We cannot determine from the forms BCl_3 and Al_2Cl_3, corresponding chlorides, the different atomicities of the two elements. The partisans of atomicity compare Al_2Cl_6 with C_2Cl_6, and from it they conclude that aluminium is a tetrad: however, we are quite as much authorised to consider Al as a pentad, for AlH_4 and AlH_2 do not exist. There is no reason to admit the existence of these hypothetical bodies: the existence of $AlCl_3$ corresponding to $AlAe_3$, BCl, and BAe_3 is much more natural. A polymeric transformation of $AlCl_3$ into Al_2Cl_6 would correspond better with the polymers S_2 and S_6, CH_2 and C_2H_4, &c. Alumina is apparently a polymeric modification ($Al_{2n}O_{3n}$) in the same way as $AsCl_3$ does not correspond with As_2O_3, but with As_4O_6. $AsCl_3$ combines with the chloranhydrides as As_2O_3 does with different anhydrides: therefore, two molecules of As_2O_3 can unite in one body—

$$\left.\begin{matrix}As_2O_3\\As_2O_3\end{matrix}\right\},$$

analogous to the known compound,—

$$\left.\begin{matrix}As_2O_3\\SO_3\end{matrix}\right\}.$$

ON THE

PHENOMENON OF "FLASHING" IN ASSAYS OF GOLD,

AND ON THE

INFLUENCE OF THE METALS OF THE PLATINUM GROUP ON IT.

By Dr. A. D. VAN RIEMSDIJK,
Assayer-General of the Netherlands Mint, Utrecht.
Translated by W. CHANDLER ROBERTS, F.R.S.

WHEN 500 milligrms. of pure gold with 1 to 2 grms. of lead, or when 500 m.grms. of pure gold, 50 m.grms. of copper, with 4·5 to 5 grms. of lead, are cupelled at a temperature exceeding the melting-point of gold, and after the operation the liquid metal is withdrawn from the muffle, a comparatively long time will elapse,—thirty or forty seconds,—before the button sets. The cupelled gold, which is incandescent on leaving the muffle, cools below redness without changing its state. Suddenly the button emits a brilliant clear greenish light. This phenomenon is termed "flashing," (*l'éclair*) and the brilliancy of the glowing button diminishes while the metal cools, and ceases entirely when it sets.

"Flashing"† is always produced in a very distinct manner when 250 m.grms. of gold, 25 m.grms. of copper (the copper is essential), and 625 m.grms. of silver are cupelled with 3 to 3·5 grms. of lead (this being the ordinary composition of "check" assays weighing 0·25 grm. for the standard 900), or double this when half a gramme of metal is taken for assay.

In order to obtain good results it is necessary that the following conditions be observed:—

1. The cupellation must be conducted at least at the temperature of molten silver.
2. The alloy of gold and silver must be liquid at the moment of withdrawal from the muffle.
3. The liquid globule must present a polished surface, and there must be no indication of internal or superficial movements.
4. In removing the cupel containing the button from the muffle, care must be taken to avoid the least shock or rough movement.
5. Cooling must be effected in a uniform manner.

When these conditions are duly observed, the metal, which is heated above its melting-point and luminous at the moment of removal from the muffle, cools sensibly below this temperature while remaining in the liquid state. It cools below redness, ceases to be luminous, and then suddenly "flashes." This development of intense heat again raises the metal to its melting-point (about clear cherry redness), and only then does it begin to solidify while gradually losing its latent heat of fusion.

I believe that the "flashing" may be perfectly explained by the superfusion to which gold and its alloy with copper or with silver and copper are subjected, when cupelled at a high temperature with lead in excess. There is a limit of temperature below which the fluid metal cannot cool without suddenly parting with all its latent heat of fusion, and this re-heats the cooled globule to its true melting-point, which in the case of gold and the alloy with silver, is above 1000° C. But it is an admitted fact that solid or liquid bodies so raised to a high degree of heat often emit a peculiarly intense light, and this light is known in the experiments before us as the "flashing" which precedes the solidification of cupelled gold.

The phenomenon of superfusion was observed first by Fahrenheit (1724) in the case of water, which he was able to cool to −9·4° C. without freezing. Blagden, Gay-Lussac, Despretz, Dufour, Berger, Mohr, Gernez, and other physicists have confirmed this remarkable fact,* which has been established also in the case of other bodies, such as sulphur, phosphorus, and naphthaline, as well as in acetic, sulphuric, and phenic acids.

Hitherto the metals do not appear to have been the object of special study from the point of view of superfusion.

Faraday,† in his memoir "On Regelation," Sept., 1858, states: "Acetic acid, sulphur, phosphorus, *many metals*, many solutions, may be cooled below the congealing temperature prior to the solidification of the first portions," while in the Treatises on Physics, of Daguin (vol. 1, p. 892, 1855) and of Jamin (vol. 1, p. 105, 1859), tin only is mentioned as being able to retain the liquid state to 225·5° C., although its true point of fusion is 228° C. The classical researches of D. Gernez‡ are of the highest interest in connection with the question before us. I will cite the following passage from M. Gernez: "It is found that certain supersaturated solutions and all the superfused liquids can be made to crystallise by the friction, more or less energetic, of two solid bodies within the fluid; but, apart from this mechanical action, which has no effect on most supersaturated solutions, the only cause that induces solidification within certain limits of temperature, is the contact of a body which must be rigorously isomorphous or identical with the substance melted or dissolved." In fact, if, after the button

† The phenomenon here called "flashing" is not identical with that which many writers on assaying have called "l'éclair," fulguration, coruscation, and brightening, but it is the same as the l'éclair of M. Levol in his "Etude de quelquesung des phénoménes qui se produisent dans la coupellation des alliages d'argent et d'or" (1845).

* See also the very remarkable article of M. J. Jamin in the *Revue des deux Mondes*, for February, 1879, entitled "Le Verglas du 23 Janvier.'

† "Experimental Researches in Chemistry and Physics," p. 3·9.

‡ *Comptes Rendus*, 63, p. 217 (1866); *Revue des Cours Scientifiques* vol. 4, p. 224 (1866-7).

of gold is withdrawn from the muffle in a liquid state, and when it has cooled down below its normal point of solidification, but before attaining the limit of temperature which the superfused metal cannot pass without changing state, it is touched lightly with the extremity of a fine wire of pure gold, "flashing" will be produced instantly. The metal then sets in accordance with the ordinary laws of solidification.

This explanation of the phenomenon of flashing appears to me to be more in accordance with the observed facts than the interpretation of M. Levol,* in his memoir published in 1845, which contains, however, many facts of the highest interest in connection with assaying.

I have also studied the effect of certain metals on the superfusion of gold cupelled with excess of lead. It may be well to observe that gold fused on a cupel *without the addition of lead* is not subject to superfusion; it sets gradually without "flashing" as soon as its temperature falls to the true point of solidification.

The metals which I have added to pure gold are the following:—Magnesium, aluminium, zinc, cadmium, iron, nickel, bismuth, tin, antimony, copper, silver, palladium, platinum, iridium, rhodium, ruthenium, osmium, osmium-iridium.†

The addition of some thousandths of all but the last five of these metals, that is, from magnesium to platinum inclusive, does not in any way interfere with the "flashing" of cupelled gold, or of ordinary assays on the standard 900 composed of gold, silver, and copper. On the other hand, when gold or its alloy, either with copper or with silver and copper, contains a more or less considerable quantity of iridium, rhodium, ruthenium, osmium, or osmium-iridium, the members of the platinum group which are non-malleable, refractory to heat, and resist the action of acids, the tendency of the cupelled metal to preserve its liquid state below the melting-point, and therefore to "flash" before final solidification, is entirely prevented.

The following is a brief statement of the results of a considerable number of experiments. On cupelling gold with excess of lead, together with eleven-thousandths of magnesium: a liquid button incrusted with a mixture of oxides of lead and magnesium was obtained. Notwithstanding the abnormal layer on its surface, the solidification of the metal was retarded, and it "flashed" very distinctly. With aluminium, zinc, cadmium, iron, nickel, tin, and antimony added to the pure gold in quantities not exceeding 12·5 thousandths, the flashings invariably took place, the buttons of cupelled gold presenting under these conditions the ordinary brilliant yellow surface.

According to the experiments of Dufay in 1727, confirmed later by Chaudet,‡ lead may be replaced in cupellation by bismuth. Pure gold cupelled with excess of bismuth "flashed" with great intensity. Copper promotes the superfusion of gold. When 500 m.grms. of gold and 50 m.grms. of copper are cupelled with 5 to 6 grms. of lead, the button remains liquid during 45 to 50 seconds before "flashing," while gold cupelled without the addition of copper sets in 30 to 35 seconds after the actual withdrawal of the cupel from the muffle.

Pure silver interferes with the phenomenon of flashing as soon as it is alloyed with gold in the proportion of 375 thousandths and upwards.

I explain this fact by the well-known property possessed by molten silver of absorbing oxygen, which is evolved when the metal solidifies, giving rise to the effect known as "springing." This destroys the internal quiescence of the liquid mass that is essential to its maintenance in the superfused state.

This resistance of silver to the phenomenon of "flashing", may be overcome by the addition to its alloy with gold of a certain quantity of copper. When 625 m.grms. of silver* are cupelled with 250 m.grms. of gold and 25 m.grms. of copper and 3 grms. of lead, and the cupel is removed from the muffle at the moment when the button clears and shines brightly, the cupelled alloy remains for an abnormal length of time in the liquid state, down to a temperature well below the ordinary melting-point of the alloy in question. A sudden light terminates this state of superfusion and the button sets, presenting an even dead white surface with a slight depression at its centre. If, instead of waiting for the limiting temperature to be reached, momentary contact is made with a small portion of solid silver, the superfused state is abruptly disturbed, the metal "flashes," and then solidifies.

Palladium and platinum, the only metals of the platinum group that are malleable, ductile, and soluble in *aqua regia*, do not hinder the superfusion and flashing of cupelled gold. I have added as much as 12·5 thousandths of palladium, and even 22 thousandths of platinum to pure gold, or cupriferous gold (and its alloy, with silver), without preventing flashing, which occurred in fact with much intensity.

But the case is very different when it becomes a question of adding other metals of the same group. It is only necessary to add an infinitesimal portion of one or more of these metals before cupellation with excess of lead to produce an alloy, which, when removed from the muffle in the molten state, solidifies, almost directly, in the ordinary way without flashing, superfusion having been prevented. With cupriferous gold, or with an ordinary assay of 900 standard to which some traces of iridium, rhodium, ruthenium, osmium, or osmium-iridium† have been added, the same results are obtained; that is to say, there is normal and rapid solidification, absence of flashing, and the production (in the ordinary assay) of a solid button with a surface which is brilliant but irregular and rough.

The quantities I employed varied as follows:—

Iridium	from 0·33 to 25·5		thousandths
Rhodium	,, 0·16 to 12·0		,,
Ruthenium	,, 0·27 to 12·75		,,
Osmium	,, 0·42 to 12·0		,,
Osmium-iridium	,, 0·50 to 4·5		,,

The explanation of the absence of flashing in all these experiments may be found, I believe, in the following fact:—Gold and silver alloy perfectly with platinum and palladium. As in the molten state these alloys are homogeneous and perfectly liquid, the phenomenon of superfusion cannot, in their case, be considered extraordinary. But the other metals of the platinum group do not combine, or only with difficulty, with gold or with the gold-silver alloy, a fact which was observed long since by Berzelius in the case of osmium-iridium. It is only necessary to assume, however, that within the liquid cupelled metal the particles of iridium, ruthenium, &c., are present in the solid uncombined state, to account, on the theory of M. Gernez, for the entire absence of flashing, which, as we have seen, is closely connected with the retardation of solidification of gold (either pure or alloyed with copper) when it is cupelled with excess of lead.

There is another reason, in many cases, for the non-production of either superfusion or "flashing." When a little iridium, ruthenium, osmium, &c., is added to an ordinary assay of gold of 900 standard, and the cupellation is conducted at a high temperature, the button, after removal from the muffle, will clearly show a sparkling surface caused by the development of microscopic gaseous bubbles. These probably consist of osmic acid when osmium has been added, or of oxygen in the case

* *Ann. Chim. et de Phys*, (3), vol. 15, p. 55.

† The well-known metallurgists, Messrs. Johnson, Matthey, and Co., of London, have furnished me with very pure specimens of metals of the platinum group.

‡ *Ann. Chim. et de Phys.*, vol. 8, p. 113 (1818).

* This refers to the assay piece of ½ grm. of standard 900 composed of pure metals. Double this must be employed when ½ a grm. of metal is taken for assay.

† A complex natural alloy which always contains rhodium and ruthenium in small quantities (Deville and Wolcott Gibbs) often found associated with gold and silver in Russia, America, and Australia.

of iridium or ruthenium. This agitation of the molten mass destroys the molecular quiescence necessary to preserve it in the superfused state below the normal solidification point.

I now come to the useful application of the results of these researches. They point to a very simple but effective method for detecting the presence of one or more metals of the platinum group (except platinum itself and palladium) in ingots of commercial gold, coins, or works of art. It is only necessary to cupel 0·5 grm. of the alloys with excess of lead at the temperature of molten gold; if the assays solidify directly they are withdrawn from the muffle without "flashing," it is safe to conclude that the metal undoubtedly contains iridium, ruthenium, rhodium, osmium, or osmium-iridium. This is true of ordinary assays provided they contain the requisite quantities of silver and copper. After cupellation, the alloys will remain in the superfused state, and will "flash" before solidification in the exceptional cases in which they are free from the above-named metals. In fact, commercial gold, most of the ingots furnished by refineries in which the sulphuric acid method of parting is employed, and nearly all coins, contain notable quantities of metals of the platinum group, probably osmium-iridium. The non-flashing of the assays, the bright and rough appearance of the buttons, the sparkling of the liquid mass before solidification, afford unmistakeable evidence of this fact, while the "check" assays, consisting of pure gold, silver, and copper, assayed side by side in the muffle with the experimental alloys, give buttons with a smooth, uniform, dull surface, which in all cases exhibit "flashing," and pass through the superfused state.

By the aid of *aqua regia* it is easy to separate from an alloy of gold which has not "flashed" after cupellation, the metals of the platinum group that are insoluble in the mixed acids. They will be found in the form of blackish powder mixed with chloride of silver on the filter through which the solution of gold, previously diluted with distilled water, is passed. The chloride of silver may be removed from the filter by boiling ammonia, and the gold precipitated from solution by sulphurous anhydride. Two experiments may be cited, as they entirely confirm the explanation we have given.

1. Wrap ½ grm. of pure gold in the dry filter which contains the traces of iridium, &c., and cupel it with 1 or 1½ grms. of lead. The non-flashing and non-superfusion of the alloy will afford evidence of the addition of the metals of the platinum group which are insoluble in *aqua regia*.
2. Wash and dry the finely-divided gold reduced from the chloride, and cupel ½ grm. with 1 grm. of lead: the flashing will take place with intensity, for by the parting with *aqua regia* the commercial metal has been freed from the iridium and the three other insoluble metals of the platinum group.

The method of assaying gold, so exact when the alloys only contain silver and copper in addition to the gold, is not trustworthy in the presence of appreciable quantities of members of the platinum group that are insoluble in *aqua regia*. These metals, mixed with gold and silver, are not absorbed by the cupel, but are partially oxidised in the muffle in contact with oxygen and lead. MM. Deville and Debray* have proved this in the case of iridium and rhodium, and I have shown that it is also true in the case of ruthenium and osmium, the latter metal disappearing entirely in the state of gaseous osmic acid when it is cupelled alone with the necessary amount of lead. But if it is mixed with gold or silver it is impossible to separate the osmium entirely by this operation, as traces always remain in the button. By parting impure gold, after the usual cupellation, in nitric acid, and boiling, as is usual, twice, cornets are obtained which have a considerable "surcharge" caused by the iridium and other metals insoluble in nitric or sulphuric acid that are retained in the cornet. Such cornets cupelled with lead at a high temperature never "flash," while cornets from gold free from iridium, &c., always pass to the superfused state, and only solidify after intense "flashing." This affords, therefore, a valuable means of controlling the results of assays of commercial gold, for the absence of "flashing" in such assays proves:—1st. That the original alloy contained notable traces of osmium-iridium; 2nd, that the "fineness" deduced by calculation from the weight of the cornets is above the truth on account of the iridium, &c., which the parting by nitric acid has failed to remove. Availing myself of this method of investigation, I have been able to satisfy myself in a great number of cases—

1st. That when small quantities amounting to 5-10,000ths and over of ruthenium and osmium-iridium (which generally contains ruthenium) are present in the alloys submitted to assays, they are retained in the cornets.

2nd. That the presence of about 1-1000th of iridium in the metal to be assayed does not interfere with the accuracy of the result obtained by the ordinary method. On parting with nitric acid such an amount of iridium is removed with the silver; but if more than 1-1000th be present the buttons do not "flash," and the cornets have a considerable surcharge.

3rd. That 2-1000ths of rhodium may be added to gold without exercising any marked influence on the phenomenon of "flashing;" but if the metal contains more than this amount there will be neither superfusion nor "flashing." Rhodium is the only metal of the platinum group of which the presence of 25-10,000ths and upwards is indicated by distinctly modifying the process of cupellation. At the end of the operation the buttons "uncover," that is, the last traces of lead leave them with difficulty; they set directly they are withdrawn from the muffle, and adhere firmly to the cupel. The buttons are no longer characterised by the usual dull white surface of silver, but assume a rose tint, which becomes red-brown or even blackish when the quantity of rhodium is increased.

4th. That osmium added to gold in quantities of over 2-1000ths is found in part in the cornets. If the metal contains less than 2-1000ths the buttons "flash" in a very marked manner. If the amount of osmium exceeds 2-1000ths the assays sustain a considerable mechanical loss during cupellation, which arises from the evolution of gaseous osmic acid, globules of molten metal being scattered beyond the cupel. It is impossible in such cases to determine even approximately the true standard of the alloys under examination.

5th. The examination of *cornets* from assays of commercial gold, ingots, or coins from various sources, by the simple method I have indicated, teaches us the sad fact that many, if not most, of the buttons do not flash when the cornets are cupelled with lead. It will be evident from the preceding considerations that none of these cornets give, in the first instance, the true standard of the gold submitted to assay, on account of the "surcharge" arising from retention of osmium-iridium, a natural compound which is so often found in geological formations rich in gold and silver.

It sometimes happens that when metal from different parts of an ingot or coin of gold is assayed, some buttons flash and others do not. This may be explained by the irregular distribution of the iridium and other insoluble metals of the platinum group, in the gold and silver, with which metals they are not alloyed. The grains of osmium-iridium are, in fact, distributed through a mass of commercial gold just as fine grains of sand might be scattered through wax. They are certainly not in the state of solution or combination, which can alone produce an homogeneous alloy.

The processes adopted, both in Russia and in America,*

* *Ann. Chim. et de Pyhs.*, [3], v. 61 p. 81 (1861).

* Dubois, *Bull. Soc. d'Encouragement.* Jan. 1856, p. 31. Wysocki, *Dingler's Polyt. Journ.*, v. 146, p. 47. Wolcott Gibbs, *American Journ. of Science and Arts*, January, 1861.

for separating iridium and osmium-iridium from gold or from the gold-silver alloys, are based on difference in specific gravity, as well as on the fact that these metals do not combine with gold or silver.*

The molten mass is allowed to stand for some time in order that the grains of osmium-iridium may collect at the bottom of the crucible, and by carefully pouring away the supernatant metal, an alloy rich in osmium-iridium remains. This method appears to me to be inadequate for obtaining gold perfectly free from iridium, as it is often met with in the state of microscopic particles distributed through a medium, itself of high density.

It is only by chemical means that these metals can be perfectly separated from gold. This separation cannot be effected by the ordinary parting with sulphuric acid, which neither attack the gold nor the metals of the platinum group; but it is necessary to employ the process of parting with *aqua regia*, which has been used for some years with great success in the refinery of Messrs. Rössler,† at Frankfort, where gold extracted by boiling sulphuric acid from the silver coin withdrawn from circulation in Germany, is re-dissolved in *aqua regia*. The solution of auric chloride is allowed to clear, and is largely diluted with water, when the gold is precipitated in a very pure state by means of ferrous chloride. This gold is met with in commerce under the name of "Frankfurter Scheidegold," and I found on assay that its standard is 999·4. When cupelled with the necessary amount of lead it was freely maintained in the superfused state, and "flashed" with great intensity.

In conclusion, I would draw attention to this novel mode of investigating the causes of the non-malleability that is at times observable in the preparation of gold for coinage. The alloyed metal, although it may have shown no signs of fracture in passing through the ordinary rolls, is occasionally found to crack irregularly in traversing the draw-bench. I believe this to arise from the presence of streaks of iridium, osmium-iridium, &c., which destroy the continuity of the metal, rendering it locally brittle. The absence of "flashing," when such a gold alloy is cupelled with lead, will afford evidence of this being the case. I intend to thoroughly investigate this question as soon as the manufacture of gold coin is undertaken in the Netherlands Mint.

I sincerely wish that the large refineries of Europe and America would, for the future, follow the example of Messrs. Rössler, of Frankfort, in order that Mints might be supplied with ingots of gold free from osmium-iridium, for the admixture of gold with such metals of the platinum group seriously affects the malleability and homogeneity of the alloys used for coinage, and is the worst enemy of the method of assay now in use in our laboratories.

* Density of iridium .. .. 22·38
" osmium-iridium .. .. .. 18·9 to 21·1
" gold .. .. 19·3
" silver .. .. 10·5

† *Annalen der Chemie und Pharmacie*, vol. 180, p. 240 (1876).

ON THE COMPOSITION AND ANALYSIS OF WELDON MUD.

By Dr. LUNGE,
Professor at the Federal Polytechnicum, Zurich.

The mass obtained in the recovery of manganese by Weldon's process is, to the best of my knowledge, tested at all works practically in the same way, which has been indicated by Mr. Weldon himself, viz., for manganese peroxide, total manganese, and base. No doubt the testings made at different works differ slightly in details, but the principle remains always the same, and it is of course quite unnecessary for me to enter into any description of it. Some years ago I gave a description of these analytical processes in a German periodical (*Dingler's Journal*, vol. ccxv., p. 157), embodying some modifications which I had found to be expedient, and this description is probably employed by all German works recovering the manganese according to Weldon's process as their guide in testing the mud.

Some months ago, Dr. Post, of Göttingen, published a paper on the composition of Weldon mud and some similar compounds (*Berliner Berichte*, vol. xii., p. 1454), and soon after another paper on the recovery of manganese peroxide (*ib.*, p. 1537) from which the conclusions would have to be drawn that the analytical methods universally employed in alkali works for testing the Weldon mud are utterly worthless and misleading, and that the theory of the existence of "manganites," of "base," &c., is quite wrong. It is only right to state that Dr. Post, whose name is very favourably known in Germany in connection with the *literature* of technical chemistry, does not possess any practical manufacturing experience, and thus would be more easily led to overlook the enormous bulk of contrary evidence which any practical alkali maker has at his fingers' end. But sometimes the theoretical men are in the right after all, and it would not do to leave their labours unheeded, even when they run contrary to the general opinion of practical men. In this special case, although I am on terms of personal friendship with Dr. Post, I felt it incumbent upon myself to investigate the question raised by him, not merely because his assertions concerning the inaccuracy of the ordinary testing methods indirectly attacked my publication on that head, but also because this matter necessarily occurs in my "Treatise on the Manufacture of Sulphuric Acid and Alkali," in which I am bound to notice every thing published in this line. I shall state at the outset that I disagree with Dr. Post's conclusions *in toto*, and that I believe to have completely established the accuracy of the ordinary testing methods, and of the assumption as to the existence of a "base" in the Weldon mud. But I have extended my investigations somewhat further, and revised the whole subject in question, as will appear hereafter.

Dr. Post rejects the testing for MnO_2 by means of a ferrous sulphate solution and re-titration of the same by potassium permanganate, because, on comparing it with the iodine method of Bunsen, he found a large difference between the two. The iron method in one instance indicated to him 77·19 per cent, the iodine method 69·15 per cent, which means that the former method yields results more than 10 per cent above the truth, Bunsen's method being considered the standard one. Dr. Post seeks the cause of this deviation in the presence of a large quantity of chlorides, which makes the final reaction in the permanganate method uncertain; the pink colour of the liquid, when first observed, goes away very quickly again. In order to have a standard of some sort, he accepted the colour first appearing, but quickly vanishing, as the final reaction; but he considers that consequently he used too little permanganate, and therefore found too much MnO_2.

Now this reasoning appears to me faulty from the outset. First, Dr. Post need not have troubled himself as to the quick disappearance of the pink colour of the liquid, but he might have accepted without the least hesitation the first distinct pink, although it vanishes again in half a minute, as the *real* end of the reaction. That this is the case innumerable testings with pure iron solutions in the absence of HCl have shown to me; neither is it at all wonderful that the colour should disappear again. It is true that this fact, well known to everybody concerned, has met with a satisfactory explanation only a short time ago. The disappearance of the pink colour is simply due to this, that potassium permanganate acts upon manganese solutions, precipitating from the same MnO_2. The small quantity of the latter is not observed at first in the yellow or brownish liquids so long as it is suspended, but it appears as a precipitate on standing for some time, often adhering to the sides of the beaker as a brown film. Recently this reaction has been utilised by several chemists

for quantitative estimations of manganese, to which I shall refer later on. Consequently the *first* turning pink must be accepted as the point when the iron is just peroxidised; but this point is marked so sharply that there is never any doubt about a single drop.

It is true that the testing of iron solutions by means of permanganate has been found to be slightly inaccurate when the iron was in solution, not as sulphate or nitrate, but as chloride, and it is to this fact that Dr. Post refers. But he loses sight of the fact that the result of that error, if it were appreciable in this case, would be just the opposite one to that which he assumes. The reason why in hydrochloric acid solutions the permanganate may cause an error is this, that a little chlorine is set free, which in dilute solutions acts too slowly on the ferrous salt, so that it is partly lost, and *more* permanganate is used than ought to be the case (comp. Fresenius, "Quantitative Analysis," sixth German edition, vol. i., p. 281; or seventh English edition, vol. i., p. 219). But Dr. Post believes that he has used *less* permanganate than he ought, and the error accordingly can have nothing to do with the chlorides.

Moreover, the chlorides are in this case practically harmless. It has been noticed before (comp. Fresenius) that in the presence of a large amount of sulphates the permanganate gives correct results even if chlorides are present; and this condition is fully realised in our case, where a large excess of ferrous sulphate and of free sulphuric acid are added in testing the Weldon mud.

Still this question had to be decided experimentally, and this was all the more incumbent upon me, as the original instruction given by Weldon prescribes re-titrating by potassium bichromate, for which I had substituted the permanganate on my own responsibility for the sake of the much greater convenience of showing the final reaction within the liquid itself. As is well known, the chlorides, or even free HCl, do not affect the bichromate test at all; perhaps Mr. Weldon selected it for this reason, but more probably because it was believed some years ago that solutions of permanganate changed their standard in time, and required frequent re-standardising—an objection which has been long proved not to exist in the case of pure, crystallised permanganate. I therefore made a number of tests of the same Weldon mud, employing always the same pipette, carefully standardised liquids (each c.c. indicating 0·004 grm. oxygen), and calibrated burettes. The same iron solution was employed in all cases, made from pure crystallised ferrous sulphate, to which its own weight of pure sulphuric acid was added. In every case 5 c.c. of the mud was taken from the thoroughly shaken-up bottle, the pipette washed outside, its contents run into a beaker, the pipette washed out with water, 25 c.c. of the iron solution added, and, when the mud was dissolved, the whole diluted to 100 c.c., and at once re-titrated, The results were as follows:—

25 c.c. iron solution = 12·70 permanganate.
= 12·70 bichromate.

5 c.c. mud + 25 c.c. iron solution required:—

Of permanganate: 2·35 − 2·35 − 2·35 − 2·35 − 2·35, equal in all tests to 10·35 permanganate, equivalent to MnO_2 = 0·2251 grm.

Of bichromate: 2·30 − 2·30 − 2·25 − 2·25, equal on the average to 10·42 bichromate for the MnO_2 = 0·2266 grm.

The difference is extremely slight; whatever it be, it is as might be expected from the above reasoning, not as assumed by Dr. Post.

Another series of tests with a different mud yielded:—Iron solution 25 c.c. = 12·3 permanganate or bichromate (five tests).

4 c.c. mud (from a 2 c.c. pipette) + 25 c.c. iron solution = 5·45 − 5·45 − 5·45 permanganate, leaving 6·85 = 0·1490 grm. MnO_2.

4 c.c. mud + 25 c.c. iron solution = 5·40 − 5·40 − 5·40 bichromate, leaving 6·90 c.c. = 0·1501 grm. MnO_2.

A similar difference to the above; which of the two results was right could only be decided by a third mode of testing. For this I selected Bunsen's iodometrical test, both on account of its general reputation of accuracy, and because Dr. Post had taken it as his own standard of comparison. He had, as appears from his description, applied it to filtered and washed mud, which must have been very awkward to weigh (as it is hardly possible to expel the water without expelling some oxygen), and awkward to get into the boiling flask. I, for my part, simply emptied my 2 c.c. pipette into the flask, washed it out into the same, added some HCl, and distilled into a solution of KI, with the usual precaution. From a number of previous experiments I had found that by far the most convenient apparatus, combining perfect accuracy with the impossibility of any mishap at the end of the distillation, is that figured in Thorpe's "Quantitative Analysis," p. 165. As the delivery tube does not dip into the absorbing liquid, there is no danger of any of the latter re-entering the boiling flask at the end. It is, however, necessary to add a little ammonium carbonate to saturate the free acid distilling over; at any rate, the re-titration with sodium arsenite (which I generally prefer to hyposulphite) is only accurate under these circumstances. The ammonium carbonate may be added directly after the distillation. Five tests required for 2 c.c. mud: 17·2 − 17·0 − 17·15 − 17·10 − 17·10, on the average 17·10, or for 4 c.c. 35·20 decinormal arsenite = 0·1488 grm. MnO_2.

This result agrees absolutely with that of the iron and permanganate test (= 0·1490) and establishes the perfect accuracy of the latter. I cannot explain the totally discordant results obtained by Dr. Post, but there *must* be some mistake about that; for one thing, he adduces only *one* comparative test, although he may have made more than he has published.

Ultimately I made a few tests with the direct iodometrical method, viz., without distillation. The manganese mud, mixed with some potassium iodide, and then with hydrochloric acid, instantly dissolves *in the cold* to a dark brown liquid, which should be neutralised with ammonium carbonate and re-titrated with sodium arsenite. The operation was performed by mixing the mud and KI in a closed flask, and introducing the HCl by a dropping funnel; but this precaution seems hardly necessary, as in the presence of KI no chlorine whatever is evolved, the whole reaction taking place in the cold, whilst without the KI the liquid must be boiled for some time before the chlorine is evolved, dilute as the liquid is in itself and by the washings of the pipette. But an accurate result can be only expected from the direct method, if no ferric oxide be present, since Fe_2Cl_6 equally sets free iodine from KI. This was confirmed by my results. I found in three tests the iodine from 2 c.c. mud = 17·4 − 17·45 − 17·30 c.c. sodium arsenite. The iron contained in the mud (estimated gravimetrically) was equal to 0·0019 grm. Fe_2O_3 = 0·24 arsenite solution, deducting which the results of the direct test agree with those of the distillation test.

I think I am entitled to say that the iron method, whether the re-titration is made by permanganate or by bichromate, indicates the percentage of MnO_2 in Weldon mud with perfect correctness. The above experiments, moreover, show that the taking of samples by means of a pipette, if done with proper care, is also an accurate operation.

(To be continued.)

Lectures to Schoolmistresses on Apparatus for Object Lessons.—It will doubtless interest many of our readers to learn that Dr. J. H. Gladstone, F.R.S., is giving a course of lectures to the mistresses of Board Schools and their assistants on the apparatus selected for illustrating object lessons. A knowledge of the elementary principles of physics and chemistry will thus in time be spread through the mass of the people, and though necessarily very rudimentary in its extent it must exert a wholesome influence on popular habits of thought.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Ordinary Meeting, March 14, 1880.

Dr. HUGGINS in the Chair.

NEW Members:—Prof. Minchin, Mr. Hulme, Mr. A. Stroh, Prof. D. E. Hughes, Lieut. Wingfield, Mr. J. Macfarlane Gray.

Mr. W. CHANDLER ROBERTS drew attention to an explanation which had recently been suggested by Dr. Van Riemsdijk, of Utrecht, to account for the "flashing" which attends the solidification of cupelled buttons of gold and silver. He showed experimentally that at the point of solidification the metals emit a flash of greenish light, which Dr. Riemsdijk thinks is probably due to the globules being really in what is known as the superfused or surfused state; that is, they fall some degrees below their point of solidification without setting, and the change from the liquid state is accompanied by the liberation of the latent heat of fusion, which again heats the globule and renders it incandescent. In an attempt to obtain indications as to the state of certain fused metals by the aid of the induction balance, Mr. Roberts was able to show that the resistance of silver in the molten state is far greater than when the metal is solid; and, on the other hand, he had confirmed De la Rue's statement that the resistance of molten bismuth is less than that of the solid metal; and he also obtained evidence that bismuth in cooling may be made to pass through a superfused state similar to that which occurs in the buttons of gold. (See page 125).

Mr. LOCKYER thought the greenish tint of the light might be due to a solid film on the globule.

The SECRETARY then read a paper by Prof. W. F. BARRETT, announcing that he had found a current of electricity to be generated by the rotation of the prepared chalk cylinder in the receiver of the Edison telephone. When the platinum stylus which rubs on the cylinder is connected through a galvanometer to the brass axle on which the cylinder is mounted a current is observed, whose E.M.F. is over ½ volt. This current falls off as the rotation continues, owing, Prof. Barrett surmises, to the electrification of the surface of the chalk. Prof. Barrett attributes the current to friction solely, and seeks to account for the receiving action of Edison's telephone by the frictional current being modified by the transmitted currents, and not by the electrolytic action to which it is usually ascribed. These experiments originated with a suggestion of Prof. Sylvanus Thompson that the Edison receiver might act as a transmitter. Prof. Barrett had at length succeeded in making it act in this capacity by means of the frictional current.

Mr. SHELFORD BIDWELL exhibited some experiments bearing on Prof. Barrett's observations, which tended to show that the source of the current in the Edison receiver was due to the fact that a voltaic element is formed by the platinum rubbing point on the brass axle and the prepared chalk. This chalk is usually impregnated with phosphate of soda, or, as in the author's experiments, with caustic potash and acetate of mercury. The cylinder seems to be dry, but is probably moist; wetting it greatly increases the current. There is a very feeble current when no motion of the cylinder takes place, but rotation of the cylinder greatly increases it. Platinum is electro-negative to brass, and hence the positive current flows from the platinum to the brass through the galvanometer. This was demonstrated by substituting zinc for platinum, when the current was reversed, and flowed from the brass to the zinc, owing to the fact that brass is electro-negative to zinc. Mr. Bidwell showed, by means of a simple pile of copper and tin-foil separated by a moist cloth or paper, that the motion of the tin across the paper increased the current of the cell. In the case of a cell made of *two* tin plates separated by moist paper, a current was set up by moving one plate over the other. The plate which moved relatively to the paper was always electro-negative to the other. Mr. Bidwell also showed by a simple experiment that the action of Edison's receiver was electrolytic. He caused the mere passage of a current to lessen the friction of a metal strap on a drum covered with moist paper, and thereby release the drum by the evolution of hydrogen.

Prof. AYRTON pointed out that the rubbing action in these experiments assisted the current by bringing up fresh electrolytic matter, a fact which had been taken advantage of in the construction of several batteries.

Prof. ADAMS remarked that this explanation did not seem to explain how the current was *reversed* in the cell composed of *two* tin-foil plates.

Prof. GUTHRIE then demonstrated by experiment a curious anomaly in frictional electricity. When flannel is rubbed with ebonite, the flannel is + electrified; when ebonite is rubbed with glass, the ebonite is + electrified and we should therefore expect that when flannel is rubbed with glass, the flannel would be still more + electrified but instead of that it is really feebly negative. Perhaps the fact that the heat of friction entered into one substance more than the other affected such results.

The SECRETARY then read a note from Mr. Ridout, stating that he had succeeded in Dr. Guthrie's funnel experiment, mentioned at last meeting, and by means of a stream of water flowing out of a glass funnel had attracted a glass cone towards the mouth of the funnel. The angle of the cone was greater than the angle of the funnel.

BIRMINGHAM PHILOSOPHICAL SOCIETY.

THE Council of the Birmingham Philosophical Society, having taken into consideration the advisability of establishing an Endowment of Research Fund, submitted the following scheme for the consideration of the Society at its meeting on March 11th.

"SCHEME FOR ESTABLISHING AND ADMINISTERING A FUND FOR THE ENDOWMENT OF RESEARCH IN BIRMINGHAM.

"The Council are of opinion that this Society would be omitting a principal means of the advancement of science—the end for which all such associations exist—if it neglected the question of the Endowment of Research. To maintain a successful investigator in his labours, even though no results of immediate or obvious utility can be shown to spring out of them, is of interest to the community at large. Indeed it is just because the practical usefulness of such work is not immediate or obvious, that it becomes necessary to give special support; for, otherwise, it would have its own market value, and endowment would be superfluous. But the proper and effectual administration of an Endowment Fund is perceived to be so beset with difficulty, as often to deter even those who recognise the principle from advocating it in practice. Most of the dangers usually foreseen would, however, as a rule be avoided, simply by the distribution of such funds from local centres, under such a scheme as is now proposed.

"THE Council are therefore anxious to establish a fund, in connection at once with the Society and the Town, for the direct endowment of scientific research. And they are further of opinion that the eminent merits of Dr. George Gore, F.R.S., as an investigator of exceptional originality and success in the domain of chemistry and physics, clearly point him out as fittest to be the first recipient of endowment from the fund. In accordance with these views the Council propose the following regulations for the fund:—

"*General Regulations.*

"I.—That the Fund be entitled, 'The Birmingham Endowment of Research Fund.'

"II.—That contributions be invited, payable either at once, or in instalments distributed over

term of years, as individual subscribers may desire.

"III.—That the money collected be deposited with the Birmingham Banking Company, in the name of the Council of the Birmingham Philosophical Society; and that all cheques on this fund be signed by the President, the Treasurer, and one of the Secretaries for the time being.

"IV.—That the management of the fund shall be in the hands of the Council of the Birmingham Philosophical Society, who shall have the power of allotting such sums and under such conditions, as they may deem fit, to any one or more persons engaged in scientific research, for the purpose of assisting them in carrying on their investigations.

"V.—The Council shall present a Report of their proceedings in connection with the fund at the Annual Meetings of the Society.

"Subject to the approval by the Society of the General Regulations, the Council have resolved—

"I.—That Dr. George Gore, F.R.S., be elected as the first recipient of an endowment from the fund.

"II.—That in order that Dr. Gore may have greater facilities for continuing in Birmingham his original researches, if the sum collected permit, the amount of £150 per annum for three years be allotted to him.

"III.—That the first cheque on the sum subscribed be payable on the 1st of July of the current year.

"H. W. CROSSKEY, R. LEVETT, } *Secretaries.*"

The above resolutions were carried unanimously at a full meeting of the Society on March 11, 1880.

NEWCASTLE CHEMICAL SOCIETY.

General Meeting, January 22, 1880.

Mr. R. C. CLAPHAM, President, in the Chair.

THE minutes of the last meeting were read and confirmed.

The names of Mr. W. Beer and Mr. T. T. Sill were read for the first time.

The PRESIDENT—I am very glad to be able to report that the two Chemical Societies are now practically united. I hope that the amalgamation will prove beneficial to both. Since we last met, one of our members, Mr. Mactear, has been conducting experiments on the crystallisation of carbon. Members may possibly have noticed the correspondence which has taken place on the subject in the *Times*, and I had hoped to have congratulated the Society to-night on the successful termination of the experiments. I have, however, had a letter from Mr. Mactear on the subject, in which he states that the substance which was supposed to be crystallised carbon is in reality not so. It is due to Mr. Mactear to state that, with a frankness which we must all admire, he wrote to the *Times* announcing his mistake as soon as he had discovered it.—The first paper which is down for discussion to-night is Mr. Berkley's, on "Magnesian Limestone Bricks." I may mention that I have had a letter from Smyrna from a Mr. Hadkinson, announcing that he is prepared to supply Greek stone in unlimited quantity at about £3 per ton, delivered in the Tyne.

Mr. LYTE—I believe we could deliver the same article at about £2 per ton.

Mr. PATTINSON—I don't think that it will be likely to come into the market at either £3 or £2 per ton when we have a material at hand which answers all the practical purposes, and costs about one-twentieth of the price. The bricks which are made in Cleveland last for an almost indefinite time. In Bolckow and Vaughan's experimental furnace the sides lasted for over three months, only the bottom of the furnace goes. I should like to mention that I was very glad to see Mr. Snelus's claim, as the inventor of the process which was afterwards developed by Thomas and Gilchrist, so fully recognised in the addendum to the President's paper which was read at the last meeting.

The PRESIDENT—The next paper is Dr. Lunge's on "Noxious Vapours." We shall be glad to hear the remarks of members on this subject.

Mr. PATTINSON—The subject is a very important one; it is difficult, in fact almost impossible, to say, from the appearance of a crop which looks unhealthy, whether it has been destroyed by noxious vapours or by frost, or atmospheric influences. If a tribunal was appointed to hear actions for damage from noxious vapours, composed of scientific men and practical chemists, who had power to use the information obtained from the inspector's reports and from their daily tests, they would very much better apportion damages than the ordinary jury at an assize trial. I think legislation in that direction is very desirable, and I should hope that Parliament, having received the report of the Commission appointed to investigate the subject, will lose no time in taking steps in the matter.

Mr. HILLS—I agree with Mr. Pattinson, that it is quite impossible to tell from the appearance of a crop the agent which has caused the damage. The average jury will generally lean towards the farmers—many of them are farmers themselves—and are really quite incapable of estimating the value of scientific evidence in a case of this nature. I should like to ask Mr. Pattinson's opinion as to the relative amount of damage caused by HCl and SO_2 in approximately equal quantities?

Mr. PATTINSON—Dr. Smith has gone into that question. For myself I am inclined to think that damage is done mostly by sulphuric acid, which escapes into the air from the roasting of copper ores and regulus.

The PRESIDENT—The information which Dr. Smith and his staff are giving to the world is certainly most valuable. Not only do the reports show that the escape of HCl has greatly decreased under the able inspectorship, but they go into many other matters as well which now, or are likely to become, of great interest. We have next to take the discussion on Mr. Swan's paper on "The Smoke of an Electric Lamp."

Professor HERSCHEL—I saw Mr. Swan to-day and he told me that the meeting to-night had quite escaped his memory, as indeed we might expect under the circumstances, and that he could not come. He therefore wished the discussion to be, if possible, postponed. He was so good as to let me have one of the lamps which had escaped the fire, and I have it on the table, wishing to exhibit by its means, after the meeting, the power of a small hand Gramme machine. This carbon candle is one of three which were saved from the fire, and as the whole of Mr. Swan's magnetic electric machines and the engine also escaped, we may hope that Mr. Swan's researches in this direction will not be long interrupted, and that he will shortly give us a lamp of greater permanency than Mr. Edison's cardboard horseshoe.

The PRESIDENT—I think, if no member has any remarks to make on Mr. Procter's paper, our next business is to listen to a paper by Dr. Lunge on "Weldon Mud."

"*On the Composition and Analysis of Weldon Mud*," by Dr. LUNGE, Professor at the Federal Polytechnicum, Zurich. (See page 129).

Disease amongst Bees.—This pestilence, which is now raging in the province of Biellâ in Italy, is traced to minute organisms, which resist the action of potassic hydrate, ether, chloroform, and of desiccation, but succumb gradually if placed in concentrated sulphuric and nitric acids.—*Les Mondes.*

CORRESPONDENCE.

ACTION OF MERCURY ON SOLUTION OF SODIUM IN AMMONIA.

To the Editor of the Chemical News.

Sir,—Messrs. Hannay and Hogarth, in their paper "On the Solution of Solids by Gases" (Chemical News, vol. xli., p. 103) describe experiments made with solution of sodium in liquefied ammonia, and mentioned incidentally that in their first trial "an unforeseen difficulty caused the experiment to fail, for the sodium solution coming in contact with the mercury was rapidly decolourised by it" (p. 105). This result is interesting, bearing as it does upon the views expressed by Prof. Seely in his article "On Ammonium, and the Solubility of Metals without Chemical Action" (Chemical News, vol. xxiii., p. 169).

Prof. Seeley found that sodium amalgam was unaffected by liquefied ammonia, though he expresses the opinion that "it is probable that at a higher temperature, or with a larger excess of sodium, some of the sodium would be removed;" and adds, "I have not yet made the experiment to determine whether mercury will remove sodium from its ammoniacal solution, but it seems extremely probable that it would so act." It is this latter remark which Messrs. Hannay and Hogarth's experiment confirms, but it appears rather to negative the proposition laid down by Prof. Seely that "the force, whatever it be, which keeps together sodium and mercury is certainly weaker than that exhibited between sodium and ammonia," and to weaken still further his already weak argument that "If sodium amalgam is not a definite chemical compound, then surely the blue liquid cannot be." The "if" in the last sentence begs the question, for we have proof, on the other hand, that sodium amalgam *is* a definite chemical compound, by the evolution of heat on bringing the two metals together, by the product crystallising on cooling, and by the definite composition of the crystals. The truth seems rather to be that the force exerted between the sodium and mercury is *greater* than that exerted between the sodium and ammonia; and for this reason, and from the absence of evolution of heat when ammonia and sodium come together, and the ready volatility of the ammonia, leaving the sodium sometimes in crystals, one may safely conclude that at ordinary temperatures the solution of sodium in liquefied ammonia is simply a physical and *not* a chemical one.—I am, &c.,

W. H. Wood.

Northgate Chambers, Halifax,
March 10, 1880.

BLOWPIPE ANALYSIS.

To the Editor of the Chemical News.

I have just obtained a copy of Landauer's "Blowpipe Analysis" (Macmillan and Co.), and I must own that I was curious to see how the first orthodox (?) writer on this subject since Major Ross would deal with his predecessor. I have so much respect for Major Ross that I do not like to say that he is wrong in some of his views, I will only say that on some points (vesiculation and ellychnine pyrochrome, for instance) my experience does not coincide with his, but that he has taught the world at large more in the way of blowpipe analysis than anyone except Berzelius and Plattner is, I think, undeniable. But he has, at the same time, said some hard things, and some things which are awkward to refute, about one or two pet chemical theories of the present day, and this has caused a certain amount of opposition to him. Landauer has adopted Major Ross's discovery of aluminium plate as a substitute for charcoal so far as obtaining metallic incrustations go, and he does so with the proper acknowledgments and references, so that it is the more inexplicable why it is that he has overlooked the equally valuable discovery of the reactions of the earths with boracic acid. These reactions determine (at once and clearly) lime and magnesia in all combinations except with phosphoric and silicic acids, and after some experience even with silica, if the proportion of silica is not too great. Also, by means of the differences between the reactions with boracic acid, borax, and microcosmic salt: alumina, silica, lime, magnesia, barium, and strontium may be distinguished from each other in salts certainly, and in mineral combinations generally; the predominant ingredient is always distinguishable. Now here we have an extension of blowpipe analysis such as has not been given to it since the days when Gahn first employed platinum wire as a holder for the borax bead, and yet not the slightest notice is taken of it in this the latest work on the subject. That this discovery will not be lost I am well aware, but it is in the hope of drawing attention to it and making it more generally known that I am induced to write you this letter.—I am, &c.,

Triton.

TRANSPARENCY OF GOLD.

To the Editor of the Chemical News.

Sir,—I have frequently seen the statement that gold has the property of transmitting light when in thin plates, and Faraday's experiments are frequently quoted as demonstrating this fact. I have never yet seen the following experiment given, although it may have been noticed before.

If a solution of gold in *aqua regia* be neutralised with carbonate of soda, and the gold precipitated by adding solution of oxalic acid to the hot gold solution, the gold is precipitated as a yellow powder, showing bright gold-coloured spangles. On examining this precipitate by the microscope these spangles will be found to be triangular and hexagonal plates which transmit light, the colour of the light being dependent on the thickness of the crystal, and when one crystal happens to overlie another the edges are sharply defined by the difference in colour.—I am, &c.,

G. P. Girdwood.

Laboratory, McGill College University,
Montreal, February 21, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 7, February 16, 1880.

Studies on Persulphuric Acid.—M. Berthelot.—The author has succeeded, by electrolysis, in preparing liquids containing 88 grms. of persulphuric acid, S_2O_7 per litre, and even reaching 123 grms.; the latter liquid containing at the same time 375 grms. of sulphuric acid, S_2O_6, and 850 grms. of water. The relation between the weights of the two acids is 1 : 3, and the liquid contains seven times its volume of active oxygen. He obtains these results by placing dilute sulphuric acid, for instance, $SO_4H + 10HO$ in a porous vessel surrounded by a concentric vessel filled with the same liquid; the liquids are cooled by means of water circulating in two worms, and the electrodes consist of stout platinum wires soldered in glass tubes. It is convenient to employ 6 or 9 Bunsen elements grouped by twos or by threes. The slow decomposition of the persulphuric acid is attended with the formation of oxygenated water.

Certain New Derivatives of Nicotine.—A. Cahours and A. Etard.—The authors have previously (*Comptes Rendus*, lxxxviii., p. 999) obtained and described thio-tetrapyridin. They have since obtained from it an acid, the

nicotianic or carboxy-pyridic of Laiblin, and a compound, which they regard as iso-dipyridin, and which is readily separable from nicotin by its insolubility in cold water.

New Interference Fringes.—M. Gouy.—The fringes which the author describes are produced by a single wave, resembling in this respect the supernumerary bows which sometimes accompany the rainbow, the theory of which has been given by Mr. Airy.

Density of Certain Gases at High Temperatures.—J. M. Crafts.—As a preliminary to experiments upon chlorine the author has made observations upon other gases—ammonia, carbonic acid, hydrogen, nitrogen, and hydrochloric acid. As regards the latter he has found its density normal at the highest temperature of the furnace. In a note the author suggests that the oxygen found by M. Meyer, and ascribed by him to the dissociation of chlorine, may have had its origin in the passage of watery vapour through the sides of the porcelain cylinder.

Action of Water upon Silicon and Boron Fluorides, and Solution of Cyanogen in Water.—H. Hammerl.—The mean heat disengaged by the reaction of an equivalent of SiF_4 upon an excess of water is + 22·34 cals. That liberated by an equivalent of BF_3 under the same circumstances = + 24·51 cals. In case of cyanogen the mean heat liberated by the solution of cyanogen = + 6·8 cals. per molecular vol. 22·3 litres.

Reproduction of Amphigen.—P. Hautefeuille.—This mineral may be artificially produced, either by the method of MM. Fouqué and Lévy, or that which the author has used for the reproduction of orthose and albite.

Martite of Brazil.—M. Gorceix.—This mineral is found in abundance in Minas Geraes in brilliant crystals of an octahedral form, and yielding a red powder when crushed. The author considers that they are merely modified pyrites

Moniteur Scientifique, Quesneville.
January, 1880.

Discussion on the Etiology of Carbuncle.—MM. Colin and Pasteur.—An account of a discussion at the Academy of Medicine.

Theory of the Saccharification of Amylaceous Matters —M. Dubrunfaut.—Already noticed.

Report on Petroleum.—J. Lawrence Smith.—A report drawn up in connection with the Philadelphia Exhibition, containing much valuable matter but quite incapable of abridgment.

Determination of Soluble Phosphoric Acid in Superphosphates.—MM. E. Wein, Roesch, and J. Lehmann.—Already noticed.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 5, January 29, 1880.

Description of the Processes for Plating with Nickel.—Paul Laurencin.—This summary, taken from *Science pour Tous*, is intended to meet the requirements of amateurs.

Mechanical Equivalent of Fat in Cattle being Fattened.—M. Dubrunfaut.—The author points out that the increase of muscular fibre (meat, properly so-called) is not connected with the fattening process. An adult ox properly fed does not materially change in weight. If yoked to the plough it effects in a day of nine or ten hours a quantity of mechanical work, not less than that of a good horse. This work is effected by the consumption of 20 kilos. of good hay and may be valued at 2,160,000 kilogrammetres, representing a thermic equivalent of 5080 calories. The same animal put to fatten on the same diet without the production of mechanical labour yields a quantity of fat not less than 1 kilo. daily. We have then the equivalence of two numbers which express respectively the value of mechanical work and the production of fat. But 1 kilo. of good fat in normal combustion liberates 8 to 9 thousand calories; or about double the thermic equivalent of the mechanical work of the animal.

Dynamometric Machine of M. Lotin.—This paper cannot be intelligibly reproduced without the accompanying illustrations.

No. 6, February 5, 1880.

Light emitted by Gases under the Influence of Electric Discharges.—E. Wiedeman.—The author seeks to explain the formation of the different kinds of spectra by means of the kinetic theory of gases.

Extraction of Perfumes with Methyl Chloride.—Already noticed.

Aluminium Wires for the Telegraph.—The conductivity of aluminium is double that of iron; it is also lighter and a thinner wire can be used. As its high price is a practical difficulty an alloy of aluminium and iron has been suggested.

Application of the Microphone to Physiological Researches.—G. Trové and H. de Boyer.—The authors have modified the microphone for this purpose, and have utilised it in the study of muscular contraction.

MISCELLANEOUS.

Society of Arts.—The following are the papers to be read at the meetings of the Society of Arts after Easter, so far as the arrangements are yet complete:—April 2, "The Best Route for a Line of Railway to India," by B. Haughton, C.E. April 6, "Art in Japan," by C. Pfoundes, April 7, "Buildings for Secondary Educational Purposes," by E. C. Robins, F.S.A., F.R.I.B.A. April 8, "Recent Improvements in Benzine Colours," by F. J. Friswell. F.C.S. April 14, "The History of the Art of Bookbinding," by Henry B. Wheatley, F.S.A. April 16, "Russia's Influence over the Inhabitants of Central Asia during the last Ten Years," by Prof. Vambéry. April 21, "The Present System of Obtaining Materials in use by Artist Painters, as compared with that of the Old Masters,' by W. Holman Hunt. April 22, "On some Recent Advances in the Science of Photography," by Captain Abney," R.E., F.R.S. April 27, "Iceland and its Resources," by C. G. W. Lock. April 28, "Recent Improvements in Gas Furnaces for Domestic and Laboratory Purposes," by Thomas Fletcher. May 5, "The last Forty Years of Agricultural Experience," by John C. Morton. May 7, "The Present Condition and Prospects of Agriculture in South India," by W. Robertson, M.R.C.A. May 13, "The Optical Properties of Crystals, and some of their Practical Applications," by Prof. W. G. Adams, F.R.S. The course of Cantor Lectures, which will be delivered during the same period, will be the third for the present session. It will consist of six lectures, by Mr. R. W. Edis, F.S.A., on "Art Decoration and Furniture," to be given on the following dates:—April 5, 12, 19, 26; May 3, 10.

MEETINGS FOR THE WEEK.

Monday, 22th.—Medical, 8.30.
—— Royal Geographical, 8.30.
Tuesday, 23rd.—Civil Engineers, 8.
—— Anthropological Institute, 8.
Wednesday, 24th.—Geological, 8.

NOTICE TO ADVERTISERS.

In consequence of GOOD FRIDAY occurring in the ensuing week, the Chemical News *will be published on Thursday next, March the 25th. Advertisements must therefore be forwarded to the Office not later than* 10 *a.m. on Wednesday, the 24th instant.*

THE CHEMICAL NEWS.

Vol. XLI. No. 1061.

A CONTRIBUTION TO THE KNOWLEDGE OF CHLORINE.

By V. MEYER and H. ZÜBLIN.

The researches of C. Meyer and of one of the present writers on the behaviour of chlorine and iodine at high temperatures prove the occurrence of a decrease of density to the extent of one-third of the normal value as quite universal in the case of iodine, whilst as regards chlorine, the like phenomenon is demonstrated only in one special case, that is when the chlorine is applied in the nascent state. The experiments on chlorine were not, like those on iodine, performed with the free element, but with one of its compounds, platinous chloride, which evolves chlorine gas during the experiment, so that the latter is always in the nascent state. It appeared, therefore, important to examine how preformed free chlorine would behave at the same temperatures; or, in other words, to determine the vapour-density of free chlorine gas at a red heat.

A porcelain vessel, maintained at a yellow heat in a Perrot furnace, was completely filled with pure dry chlorine, which had been evolved from hydrochloric acid and manganese peroxide, and successively purified by water, sulphuric acid, and phosphoric anhydride. After the chlorine had remained for some time in the apparatus, and had assumed the temperature of the furnace, it was expelled by means of a current of carbonic acid, led into a solution of potassium iodide, and its quantity was determined by titrating the liberated iodine with a decinormal arsenite solution. The porcelain vessel, still at the same heat, was filled with dry air, and this also, after having assumed the temperature of the furnace, was expelled from the apparatus by means of a stream of carbonic acid, collected in a graduated tube over potassa lye, and its volume was determined in the usual manner. Thus were ascertained, *a*, the quantity of chlorine, *b*, the quantity of dry air contained in one and the same porcelain vessel at the same temperature, forming the needful data for calculating the density of the chlorine. The relatively small quantities of air or of chlorine contained in the handle of the apparatus which projects out of the furnace and in the short and narrow entrance- and and exit-tubes, were determined separately and deducted from the total quantities of air (respectively chlorine), so that only such portions of air or chlorine as were in the gnited parts of the apparatus were taken into account. The apparatus at a yellow heat contained:—

Chlorine, 0·06529 grm., 0·06706 grm., 0·06670 grm.
Air, 0·02539 grm. (mean of three determinations.)

Hence the density of chlorine was found as 2·57, 2·63, 2·64, or in the mean 2·61. This number agrees satisfactorily with the value calculated for $Cl_2 = 2·45$, whilst when operating with nascent chlorine from platinous chloride at low temperatures, a similar value (2·42 and 2·46) was obtained, but at a yellow heat the numbers 1·65, 1·66, 1·66, 1·67, 1·60, 1·62, corresponding to 1·63, the value calculated for $\frac{3}{2}Cl_2$.

From these experiments there follows the interesting result that the dissociation of chlorine to molecules of the magnitude $\frac{3}{2}Cl_2$, which takes place on the employment of nascent chlorine at a yellow heat, does not appear at the same temperature when ready-formed free chlorine is used; whilst, on the other hand, iodine, even when applied as a free halogen, undergoes the conversion into $\frac{3}{2}I_2$, and at a decidedly lower temperature.

What may be the cause of the different behaviour of nascent and of free chlorine cannot for the present be ascertained. It may perhaps be sought in the less stable state, which bodies are apt to show during the nascent state. But it is also possible that other and more mechanical causes may occur, upon which the authors will enter in a future memoir.

They wish to point out for the present that the existence of chlorine Cl_2, and of chlorine $\frac{3}{2}Cl_2$, at one and the same temperature, as these experiments prove, is distinctly analogous to the fact that oxygen and ozone, which in their respective densities show the same relation as the two modifications of chlorine, can exist at the like temperature and even side by side.

The above-mentioned experiments were completed when the authors received information of the researches of M. Crafts (*Comptes Rendus*, xc., p. 183), on the density of the halogens at ignition temperatures. His results agree with theirs most perfectly. M. Crafts also found for iodine the density $\frac{3}{2}I_2$, but for chlorine, which he introduced into the apparatus in the free state, Cl_2.—*Berichte der Deutschen Chem. Gesellschaft.*

BALMAIN'S LUMINOUS PAINT.*

By C. W. HEATON, F.C.S.

I have been invited to give this evening an account of one of those practical applications of science which have always had peculiar interest for members of this Society. In doing so I shall be compelled to allude briefly to some scientific truths, familiar to many among my audience, and particularly to those who attended Mr. Preece's recent and interesting lectures.

Everyone knows that a ray of white light consists of minute waves, or ripples, analogous to those of water, and of various lengths. The mean length of these waves, measured from the crest of one to the crest of the next, may be taken as the fifty-thousandth of an inch. They all travel in straight lines, and all with the same velocity, a velocity which is called the velocity of light. In passing through a prism, these lines of waves are refracted or bent, at different angles, and when afterwards allowed to fall on the screen they are reflected back to our eyes, and a portion of them, acting on the optic nerve, produce the sensation of colour. These rays are, therefore, called the visible rays. Here on the screen you see the spectrum of the white electric light.

The eye is, however, a very imperfect optical instrument, and is only sensitive to waves between certain limits of length. The real spectrum on the screen is much larger than the visible one. There is a portion beyond the red which is called the ultra-red portion. The waves of this portion are too long to affect the eye, but are powerful in producing the phenomena of heat. The rays are therefore sometimes called the invisible or obscure heat-rays. There is also a portion beyond the violet, produced by waves too short to affect the eye, but active in producing chemical and other effects. These rays are called the ultra-violet, actinic, or chemical rays.

Many years ago Sir John Herschell observed the peculiar blue opalescence which a solution of quinine presents when held in certain lights. Brewster made further observations of the same kind; but it was not until 1852 that Prof. Stokes, of Cambridge, published the memorable research on the subject which would alone have been sufficient to render his name immortal in the history of science. Stokes suggested the name fluorescence for the phenomenon, and showed that it was due to a power which some bodies possess of absorbing light waves and emitting them again as longer waves. Quinine is peculiarly sensitive to violet and ultra-violet rays. If I pass a solution of quinine through the spectrum, beginning at the red end, you will

* A Lecture delivered before the Society of Arts, March 11, 1880.

see that the fluorescence does not appear until we reach the blue portion, but continues to be visible far beyond the violet. In the ultra-violet portion we have a distinct conversion of invisible actinic into visible light rays. Here is a solution of the new Magdala red made from naphthalin. It appears black in all parts of the spectrum except the region of the yellow, in which it shows a magnificent red fluorescence. This experiment proves that fluorescence is not always caused by the conversion of invisible into visible waves. We now throw a beam of electric light, filtered to some extent from heat-rays by passing through ammonio-sulphate of copper, on two jars of water, and throw into one a solution of quinine, and into the other an alkaline solution of the curious compound called fluorescine. You perceive in the one case a blue, and in the other an intense emerald-green fluorescence, and it is really difficult to believe that in each case the solution remains transparent. In fluorescence, then, we have generally, if not always, an increase of wave-length due to the molecular action of certain substances. The waves are never shortened, and are sometimes described as suffering "degradation." The luminosity ceases as soon as the incident light is withdrawn, or, to speak more cautiously, it lasts only for a minute period of time afterwards. In the case of quinine the work of converting invisible into visible rays seems to take about the 5oooth part of a second.

We come now to a closely allied, if not identical, phenomenon. Many substances are known which, having been exposed to light, continue to emit light for measurable periods of time after the luminous source is removed. This phenomenon is called phosphorescence, and it is with this that we are chiefly concerned to-night. The term phosphorescence has been applied to light emitted under various conditions. Thus we have the light emitted during the slow oxidation of phosphorus; the light of living animals, such as the glowworm and the noctiluca; the light attendant upon incipient putrefaction, animal and vegetable; the light produced by the heating of phosphorus and many other bodies; by percussion, as when sugar is struck with a hammer or rubber; and the beautiful phenomena developed in high vacua in that strange condition of matter with which Mr. Crookes's remarkable discoveries have lately made us familiar; and, lastly, we have the light which follows insolation. All these are grouped together under the general term phosphorescence, but it is with the last one that we have at present to deal.

The history of discovery in regard to this kind of phosphorescence is a somewhat lengthy one. Obscure hints of the phosphorescent power of gems are contained in some of the works of the ancients, but nothing definite was discovered until about the year 1602, when a shoemaker of Bologna, named Vincenzo Casciorolo, picked up a heavy stone, and being an enthusiastic alchemist, took it home and treated it in his furnace, in the hope of obtaining gold from it. Instead of getting gold he obtained a mass which shone in the dark, and which became celebrated as the Bologna stone, or Bologna phosphorus. The stone was the now well-known heavy spar, and acted on by carbon it yielded barium sulphide, a compound of considerable phosphorescent power. In 1663 Boyle published some observations on the phosphorescence of the diamond, and in 1675 Baudoin obtained another phosphorus by the action of heat on calcium nitrate. Some important additions to our knowledge were made by Beccaria in 1744, and then came the discovery by Canton in 1761, of the phosphorus or pyrophosphorus which bears his name. It is made by calcining oyster shells with sulphur, and consists, of course, essentially of calcium sulphide, which is the most remarkable of phosphorescent substances. Thanks to the kindness of my friend, Professor Tuson, I am able to show you a sealed tube containing a specimen of this substance prepared by Canton himself, with the date 1764 engraved on the glass. It still retains its power, a remarkable proof that the luminosity is not due to any chemical action.

In 1775 Wilson published some valuable discoveries. He extended the list of phosphori, showed that light of various colours could be obtained from them, and made some interesting observations on the effects of heat and cold, to which I shall refer again. I have here a sheet of cardboard painted with various phosphorescent compounds, and a butterfly painted on glass in the same manner. On exposing them to light you will observe the different shades of colour, varying from red to blue, which are developed.

Passing by, in this imperfect sketch, several important names, we come to the greatest name of all, Edmond Becquerel, who for more than thirty years has enriched science by his discoveries. It is impossible for me to give even an abstract of these discoveries. He invented an instrument called the phosphoroscope, by which he was able to detect the phosphorescent power in bodies which remain luminous for very short periods of time. He showed that the power was a very common one in natural as well as in artificially prepared substances, and that it was possessed by organic as well as inorganic compounds, and particularly by all fluorescent substances. He analysed the light emitted in each case by the spectrum, and determined its duration within certain limits of accuracy. These limits are singularly wide, extending from less than the 5oooth part of a second to hours or even days. Of all phosphorescent bodies, the sulphides of calcium, barium, and strontium are the most remarkable in regard to the duration of their light; and Becquerel has studied the modes of preparing these compounds with the greatest care, and has revealed many strange and even startling facts in regard to them. They can be prepared by the action of carbon on the sulphates, by the action of sulphur on the oxides and carbonates, and by the action of alkaline sulphides, and even of antimony sulphide, on the last-named compounds. The phosphori prepared by these various processes differ widely in regard to the colour and duration of the light which they emit, and it is even possible to obtain shades varying from orange-red and indigo-blue from calcium only. But this is not all. The calcium sulphide obtained from calcite is different from that from arragonite, though these minerals have the same chemical composition; and the differences remain even after each mineral has been dissolved in acid, re-precipitated by sodium carbonate, and then ignited with sulphur. This affords a strange and, for the present, inexplicable example of molecular persistency. Becquerel holds that fluorescence and phosphorescence are one and the same phenomenon, the apparent differences being due solely to the different periods during which the absorbed light is emitted. The point is one which merits attentive study.

We now come to the immediate subject of my lecture. The late Mr. Balmain, formerly of University College, and an excellent chemist, had for many years made a special study of phosporescent substances. He enjoyed the friendship of the Becquerels, father and son, and, aided possibly by them, he succeeded in producing a constant and very powerful phosphorescent substance. Here is some of the substance. You see how strong a light it emits after exposure to the magnesium light. It occurred to him to patent the use of this and other phosphorescent materials, mixed with water or oil, as paints capable of being applied in the ordinary way to any surface. This patent for luminous paint is now in the hands of Messrs. Ihlee and Horne, of Aldermanbury, and, thanks to those gentlemen, I am able to show you a great many specimens of articles thus painted, and so to enable you to judge for yourselves of its proposed applicatlons. I have, in the first place, a number of sheets of cardboard so painted, some of them framed and glazed, which you see emit, after insolation, an amount of light which is remarkable. With these sheets we can try a few preliminary experiments, which will assist in illustrating the nature of the phenomena with which we are dealing. Let us, in the first place, test the sensitiveness of the paint. Exposing a sheet of painted card, previously kept in darkness, to Leyden-jar sparks from an induction-coil, you see that each spark impresses

its image on the card and makes it luminous. It is easy in this way to write luminous words on an otherwise dark card. You know how very short a time each spark lasts, and can therefore judge of the short time required for the illumination. The same fact is more roughly shown by striking a lucifer-match in front of a dark pane. The momentary flash of the tip is, you see, enough to produce a very visible effect on the paint.

We may now try the very obvious experiment of applying light of various colours to the painted surface. Here is a card partially covered with sheets of blue, green, yellow, and red glass. Burning a piece of magnesium in front of it, you see that no effect at all is produced by the red and yellow light, a considerable effect by the green, and most of all by the violet light. The same effect may be produced in another and less ambiguous manner. We will throw the spectrum on a white screen, which consists of five horizontal layers. The upper one is white paper, the next, sensitive photographic paper*; the next, paper saturated with quinine; the next, luminous paint, which at present is dark, and the lowest luminous paint previously insolated. The spectrum covers all these layers. A long exposure is required to give a very satisfactory result, but we are then able to make out that there is great general similarity between the rays which affect the silver, the quinine, and the luminous paint. The affected portions are nearly, but not quite, coincident. If the experiment is carried on for a long time with a very intense spectrum, another effect which we could not have anticipated is observed in the lowest layer, which has previously been made luminous. The violet and ultra-violet rays increases the luminosity, as we might have expected, but the yellow and red rays not only do not add to the luminosity, but actually take away the light previously present. Another experiment will show this effect more quickly. Here is a sheet, at present luminous; I cover half of it with opaque cardboard, and the other half with yellow glass, and then burn a piece of magnesium in front of it. See the result. The rays which passed through the yellow glass, have taken nearly all the light out of that half of the card, while the light on the other remains unimpared.

For an explanation of this curious phenomenon, we must go back 105 years, to Wilson, who first observed it, though in a different manner. We must remember that red and yellow rays are also heat rays; and Wilson showed that heat would stimulate the light for a time only to cause it more rapidly to disappear. On a faintly luminous pane I place a can of hot water. Removing it after a minute, we find that the light in that place is much brighter than before. Cold diminishes the light, which, however, returns when the original temperature is restored. This I can easily show by applying a block of ice for a minute to the luminous surface. Thus we see the importance, in all experiments on the duration of phosphorescent light, of paying close attention to temperature.

We may now inquire how far this luminous paint is suited for actual use, and what kind of applications can be found for it. We have seen that it is very sensitive to artificial light. To ordinary daylight it is at least equally sensitive, and I have seen it tried, with a success which seemed to me wonderful, in a thick yellow London fog. A very short exposure produces the maximum of illumination, though, of course, the amount of this illumination depends on the quantity and quality of the light. The duration of the light is likewise dependent, to some extent, on conditions. When the paint has been exposed to the intense light of the sun, or of burning magnesium, a good deal of the brilliancy disappears quickly, but after that the fading is very slow; and it may be said that a more or less useful light will remain through the length of an ordinary winter's night. In an extreme case, I was just able to see the dial of a watch by the light emitted from a card which had been in total darkness for twenty-six hours. In this case the card had been exposed to daylight of moderate intensity for two hours.

* Kindly prepared for me by Mr. J. M. Thomson, of King's College.

The next point to be considered is the durability of the paint. The oil seems to protect it wonderfully, even from the acid air and rain of London. I have seen a wooden bowl, which was painted by Mr. Balmain more than a year ago, and has for several months been exposed to the open air in London, in very bad weather. It still preserves its power. Equally effectual is the oil as a protection from water. Here you see the painted model of a life-buoy immersed in water. Its luminosity is very evident. In several respects, therefore, namely, as regards intensity of light, lasting power, and durability under fair condition, these painted surfaces seem likely to be useful as carriers of daylight into dark places and through dark hours.

Let us now turn to the suggested applications of the paint. They may be divided roughly into the ornamental and the useful, and I need only mention a few out of the many that occur to the mind. In the former class, we may include these painted india-rubber balls, which are very pretty, and suggest nocturnal lawn tennis. Statuary, grotto-work, and ornamental tiles, also give striking and beautiful effects. Here is a large bust of the Prince Consort which has been painted and illuminated. You see how fine an effect it produces. Clock faces, so prepared, show the time all night, and watch-boxes enable us to do as much with our watches. The ends of lucifer match boxes have been painted with the same material. Here are a number of them. There would obviously be no difficulty in finding one of these boxes in the dark.

To pass to more important applications, the roofs of railway carriages have already been treated experimentally with the paint, with results that appear satisfactory. The light would, of course, only be employed for daylight trains which run through tunnels. Then, again, it is proposed to paint the names of streets, the directions at post-offices, sign-posts, and advertisements in the same way. Here are some framed notices, "Lodgings," "To Let," and such like, which would easily be seen through, at any rate, a great portion of the night. Still more important is the use of this luminous power in gunpowder magazines, spirit stores, and for purposes of exploration in coal-mines during seasons of danger, and many such uses may be thought of.

But of all the proposed uses of the luminous paint, none seem to me so important, or so certain of practical success, as the marine applications. Several of these have already been realised in a satisfactory manner. For signal and mooring buoys, for example, its utility is obvious. It is of the utmost importance that the buoys employed for marking channels should be seen easily, the safe entrance to a harbour or river frequently depending upon the successful passage through a line of buoys. The entrances to Poole Harbour and to the mouths of the Thames and Medway are marked in this way, and great difficulty and danger are often experienced on dark nights in making out the buoys. Now, there can be no doubt that a buoy thickly painted with luminous paint would remain visible through the whole, or nearly the whole, of a night. A few evenings ago, I assisted at the trial of a small mooring-buoy at Erith. It was not placed in the water till nine at night, having, of course, been for some hours before in darkness. We found that it was easily visible at distances of over a hundred yards, although the night was not a clear one, and the light to which the buoy had been exposed had not been very good. Yachtsmen, returning to moorings late at night, would find such buoys a great advantage, and many collisions might in this way be avoided. Equally important is the application of the paint to life-buoys. Life-buoys are, or should always be, kept on deck in convenient situations. A life-buoy thrown to a man overboard will often save his life, particularly if the man can swim. But what is the use of throwing out a common life-buoy on a dark night? It is impossible for the man to see it, and equally impossible for those on board. Here is a life-buoy painted with the luminous paint. It has been on the roof of this house all day, and has, consequently, been now for several hours in

darkness. Yet you see it emits a light that could easily be seen at a very considerable distance. Any decently good swimmer could easily reach it, while the ships' boats would know at once the point to which they must row.

Finally, there seems no doubt of the usefulness of the paint in diving and other submarine operations. We have ready a diver in full dress, painted all over with the luminous paint. He is being illuminated in the next room. Now he enters, and you see what a brilliant and ghost-like appearance he presents. At present one of the greatest difficulties in submarine operations arises from the intense darkness. With this new arrangement every diver will be his own lanthorn, and will carry down with him a stock of daylight that will assist his labours materially. This dress was actually so used at Southampton a day or two ago. Mr. Phillip Hedger, the Superintendent of the Southampton Dock Company, has sent this letter to Messrs. Ihlee and Horne, in which he says that the diver descended on a somewhat murky day into 27 feet of not very clear water, and found that he was able to distinguish the bolt-heads and mussels on a ship's bottom with ease. Mr. Hedger seems to entertain no doubt of the success of the new application.

Let me, in conclusion, draw your attention to the splendid inscription, "Balmain's Luminous Paint," which stretches in letters of fire the whole length of the hall. It has been in darkness for two hours, and yet illustrates very simply the way in which the paint may be made useful for advertising purposes.

I may now conclude this brief and very imperfect sketch. I heartily wish the exposition had fallen into better hands, and particularly that our Chairman, whose well-known researches on actinic light have added so much to our knowledge, would have taken the matter in hand himself. However, I have done my best, and can only hope that you have acquired some new ideas on the subject, and will in future watch with interest for further useful application of the luminous paint.

I must here express my sincere thanks to my friend Mr. Bolas, himself so excellent a lecturer, for his invaluable help in the experimental portion of my lecture.

THE LINES OF DISCOVERY IN THE HISTORY OF OZONE.

By ALBERT R. LEEDS, Ph.D.

I. Its Original Discovery, Sources, and Properties.

The history of ozone begins with the clear apprehension, in the year 1840, by Schönbein, that in the odour given off in the electrolysis of water, and accompanying discharges of frictional electricity in air, he had to deal with a distinct and important phenomenon. Schönbein's discovery did not consist in noting the odour—that had been done by Van Marum more than half a century before—but in first appreciating the importance and true meaning of the phenomenon. For while Van Marum, Cavallo, and others who followed them, connected the odour with the electricity, calling it the "electrical odour" or "aura electrica," and thus made it the property of an imponderable agent, Schönbein ascribed it to the peculiar form of matter operated upon. The hypothesis of Van Marum necessarily remained barren of fruits; that of Schönbein speedily enriched chemical science with a host of acquisitions. Clinging tenaciously to the doctrine that there could not be a variety of origin for one and the same odour, and that the kind of matter producing it in every case must be identical, Schönbein fixed his discovery by giving to that one and certain kind of matter the name of Ozone. By adhering to this guiding clue, he added, as a third source of ozone, the action of moist phosphorus upon air (1840 to 1843), and since that time, besides electrolysis, electrical influence, and the action of air upon moist phosphorus, no other sources of ozone of practical utility have been discovered.

The fact that Schönbein so stoutly insisted on, and eventually so triumphantly established, the *identity* of the ozone from whatever source derived, must not be lost sight of in any estimate of his merits as a discoverer. The earliest attack came from De la Rive, who attributed the odour to metallic oxides set free from the metals used as electrodes, or as terminals in electric discharges. But Schönbein pointed out that besides the improbability of an odour arising from solid bodies, this hypothesis required that solid bodies should have the property of indefinite suspension in the atmosphere instead of being deposited or washed down by water (1840 to 1843).

The next attacks came from Fischer, who regarded Schönbein's ozone as probably peroxide of hydrogen, and from Williamson, who thought there were two kinds of ozone,—one the ozone given off in electrolysis, and which he regarded as a higher oxide of hydrogen, differing from the previously well-known peroxide, and the other formed by the action of phosphorus on moist air. But Schönbein disposed of both objections: the first, by showing that the chemical and physical properties of ozone are not the properties of peroxide of hydrogen; the second, by demonstrating that whatever might be the true nature of ozone, the gaseous matter obtained in the electrolysis of water was in all respects identical with that formed by the action upon air of moist phosphorus (1844 to 1845).

During these first five years Schönbein was busily engaged in ascertaining the properties of ozone. Since no peculiar methods were employed in the furtherance of these discoveries, they need not detain us here further than briefly to summarise them, and to point out what corrections have been rendered necessary by the labours of subsequent investigators. They are—1st. Its eminent oxidising powers, as shown by its ability to transform most metals into their higher oxides, and to raise the lower oxides into the condition of peroxides. Certain of the non-metals—phosphorus, chlorine, bromine, and iodine—are similarly oxidised. Schönbein's statement that it does not unite with nitrogen under ordinary circumstances, but enters into combination when alkali is present, has been abundantly disproved—among others, by Berthelot (1878), who has shown that no combination occurs even when alkali is present. It oxidises sulphites and nitrites into sulphates and nitrates, and many sulphides into their corresponding sulphates. It destroys (as has since been more elaborately demonstrated by Houzeau, 1872) many gaseous compounds of hydrogen, like those with sulphur, selenium, phosphorus, iodine, arsenic, and antimony. It discharges vegetable colours, and powerfully attacks many organic bodies. The nature of its action in the latter case has been more extensively studied by Gorup-Besanez (1863), and he has described the products of the reactions which occur when ozone is allowed to act upon organic substances, alone or in presence of alkali. 2nd. According to Schönbein ozone is insoluble in water. The observations of subsequent experimenters conflict on this point, but there appears to be much evidence to show that it is soluble in water, though only in small degree. 3rd. Schönbein pointed out that atmospheric air strongly charged with ozone acts powerfully on the mucous membranes and produces symptoms of catarrh. This and his analogous discovery that ozone is present in the atmosphere, and plays there a very important part, attracted to the subject not only great popular attention, but enlisted as observers a multitude of students of medicine the world over, who hailed the newly-discovered body as an invaluable therapeutic agent, and rushed forward to establish by sufficiently numerous observations the relations between its presence or absence in the atmosphere, and the kind and prevalence of disease. Thirty years have passed away, and neither anticipation has been realised. Indeed, at the present hour, the possible value of ozone as a therapeutic agent is obscured by its having fallen into the hands of empirics; and the multiplication of inexact observations

and the crude and hasty generalisations therefrom, have covered with a sort of scientific opprobrium the whole subject of Atmospheric Ozone.

What causes have led to these lamentable results in the past; what prospects are there that both subjects can be reinstated in good scientific standing in the future?

And first with regard to ozone as a therapeutic agent. Without considering at present the unsettled questions of a medical character, as to the proper mode or amount or propriety of application, we apprehend that there have been hitherto three grave instrumental difficulties—1st. To obtain ozonised air or oxygen of known strength and of adequate purity. 2nd. It is doubtful whether in one form in which the attempt has been made to employ ozone in medicine, that of "ozonised water," any ozone whatever has been present. Such was the case with the "ozone-water" of Krebs, Kroll, and Co., in which Rammelsberg found *chlorine*. Since ozone is so slightly soluble in water at common temperatures that it is extremely difficult to demonstrate the fact of solution, the proposition to employ "ozonised water" as a remedial agent opens a wide door to quackery. 3rd. It is certain that from the mixture of potassium permanganate and sulphuric acid, which has been and is recommended as a convenient source of ozone for medical use, no ozone, but merely chlorine and oxides of chlorine (due to impurities in the permanganate) are derived.

These errors have been exposed and the difficulties overcome. There is no obstacle to having in the office of the physician, the sick-room of the patient, or the wards of the hospital, ozonisers suitable to each place, and adequate to supply ozonised air or oxygen of known strength and purity. This being the case it remains for the therapeutist to do his part of the work, and to discover when and how ozone is to be employed in legitimate practice.

Second, to detect the amount of ozone present at any time or place in the atmosphere, and the *rôle* this atmospheric ozone plays as a disease excitant or prophylatic. The objections which vitiate the observations hitherto made are two in number:—1st. The ozonoscopes hitherto employed, Houzeau's and the thallium-test included, are all affected by some one of the gaseous bodies possibly present in the atmosphere, as well as by ozone. 2nd. The method of conducting the observations is in its nature inexact, and variations in wind, temperature, humidity, &c., are allowed to increase the resultant errors.

Advance in this direction is to be looked for only when the methods at present in use are abandoned in favour of others more in harmony with those pursued in other branches of gas analysis, and when reagents are employed which will assign true values to the amounts of ozone determined.

II. The Nature of the Constituent Matter of Ozone.

In his speculations upon the nature of ozone, Schönbein was less fortunate than in his multiplied inquiries into its sources, properties, and applications. The difficulty at that time of procuring air or oxygen containing more than a minute percentage of ozone, and of manipulating it when obtained, was very great, so that precise quantitative investigations were attended with formidable obstacles, and probably for that reason were rarely instituted by Schönbein. He brought forth a variety of hypotheses, thus introducing great uncertainty into a confessedly difficult subject, and necessitating the labours of chemists during nearly a quarter of a century for their complete overthrow.

His earliest hypothesis was that ozone is a compound consisting of hydrogen and oxygen. This, in 1844, he abandoned in favour of the theory that ozone itself is elementary, and along with hydrogen enters into the composition of nitrogen, which is a compound substance. The following year he reverted to his original hypothesis, and, while maintaining strenuously that ozone is not peroxide of hydrogen, he nevertheless upheld the view that it is composed in certain unknown proportions of hydrogen and oxygen.

The second hypothesis was overthrown by the experiments of Marignac and De la Rive, who showed that ozone could not be derived from the decomposition of nitrogen, inasmuch as they obtained it by passing electric sparks through perfectly pure and dry oxygen. They proved the resultant body to be ozone, by causing it to react on moist silver and potassium iodide with the formation of argentic peroxide and iodate of potassium. They explained these reactions by supposing that under the influence of the electric discharge the oxygen had acquired an electrified condition, with exalted chemical properties: in other words, that ozone is oxygen, and oxygen only, but oxygen in an electrified state. Plausible as was this explanation, there was nothing in the experiments—water having been present in the reaction upon silver and potassium iodide—to confute the different interpretation brought forward by Schönbein, that ozone was oxygen to which in some way was added the elements of water. Nor was this point settled by a more elaborate experiment of the same nature, instituted by Fremy and Becquerel in 1853, who demonstrated that when a certain volume of oxygen is confined over an aqueous solution of potassium iodide, moist silver, or mercury, *all* of the oxygen undergoes absorption by the reagent under the influence of a sufficiently prolonged series of electric sparks.

The first to abandon the theory that hydrogen is a constituent of ozone was Schönbein himself (1849). He employed air, ozonised as strongly as possible by moist phosphorus, and afterwards dried by passage through a sulphuric acid drying tube. That water was employed in the generation of the ozone was not from Schönbein's point of view an essential element in the problem; it was whether this ozone after drying still contained the elements of water or hydrogen.

Three hundred litres of the desiccated air were passed through a narrow glass tube heated to redness, in order to decompose the ozone, and then through a second sulphuric acid drying tube. Since the latter in repeated experiments showed no increase of weight, Schönbein regarded the absence of hydrogen in ozone as conclusively proven. At the same time he did not accept the views of Marignac and De la Rive, declaring that to him the existence of an allotropic modification of a gaseous body was inconceivable. For a long time, however, the theory that ozone was a compound of hydrogen and oxygen prevailed. It derived great weight from the experiments which had been made by Williamson in 1845. He prepared ozone by electrolysis, and to avoid obtaining any hydrogen along with the electrolytic oxygen, used oxide of copper dissolved in sulphuric acid as the electrolyte. The gas was dried over calcium chloride, and then passed over ignited copper turnings into a second drying tube: this uniformly showed an increase of weight. The copper previous to ignition had been reduced by carbonic oxide, and not by hydrogen, in order to prevent the possibility of any occluded hydrogen being given up, on ignition, to the stream of ozonised oxygen.

These views were apparently confirmed by Baumert's experiments (1853). He passed the electrolytic oxygen evolved in such a manner as to exclude the presence of hydrogen, through a very long sulphuric acid drying tube, and thence into an absorption apparatus containing potassium iodide and provided with a sulphuric acid bulb-apparatus, to condense evaporated water. In case the matter of ozone and oxygen were identical, the weight of oxygen equivalent to the weight of iodine set free by the ozone should have been equivalent to the total gain in weight by the absorption apparatus. But, according to the experiments, this weight was less, and the numbers found apparently assigned to electrolytic ozone the formula H_2O_3. And since Baumert found that ozone prepared by the electric discharge could not be made to yield up the elements of water on strong heating, while that prepared by electrolysis could, he regarded the two as different bodies—the former as allotropic oxygen, the latter teroxide of hydrogen.

Thus the old hypothesis, against which Schönbein had so long striven, that there were two (and possibly more) bodies of the nature of ozone, was rehabilitated. It was finally overthrown by Andrews (1856), who showed that the preceding experiments on electrolytic ozone had been vitiated by the presence of a small but appreciable quantity of carbonic acid, which, unless very great precautions be taken, is always present in the evolved gas. In very numerous experiments he showed that the weight of active oxygen equivalent to the weight of the iodine set free in the absorption apparatus was equal to the entire gain in weight of the apparatus, and therefore no hydrogen as well could have been present; also, that the properties of electrolytic ozone, and that obtained by the action of the electrical spark on pure and dry oxygen, were identical. More especially, it was shown that both were converted into ordinary oxygen at a temperature of about 237° C.; and from the whole investigation the author drew the conclusion, which was confirmed by the still more elaborate experiments of Soret in 1863, and is now universally adopted, "that ozone, from whatever source derived, is one and the same substance, and is not a compound body, but oxygen in an altered or allotropic condition."

III. The Exact Nature of the Relations existing between Ozone and Ordinary Oxygen.

We have seen that Marignac and De la Rive, as the result of their experiments performed in 1845, had enunciated the view that ozone was oxygen in a peculiar electric state. They proposed to abandon the name "ozone," which assumed an independent chemical existence for this body, and to call it merely "electricised oxygen." This view of the constitution of ozone was one not readily susceptible of investigation by usual chemical methods. But the case was different with the hypothesis which was shortly afterwards advanced by Dr. T. Sterry Hunt, in 1848. Since his intuition of a truth, not fully demonstrated until twenty years later, is of a very striking character, it will be interesting to quote it as originally announced. In a paper on the anomalies presented in the atomic volume of sulphur and nitrogen, Dr. Hunt says—"In considering such combinations as SO_2 and SeO_2 which contain three equivalents of the elements of the oxygen group, it was necessary to admit a normal species which should be a polymer of oxygen, and be represented by O_3=(OOO). The replacement of one equivalent of oxygen by one of sulphur would yield sulphurous acid gas (OOS), and a complete metalepsis would give rise to (SSS). The first compound is probably the *ozone* of Schönbein, which the late researches of Marignac and De la Rive have shown to be in reality only oxygen in a peculiarly modified form, &c."

The hypothesis herein stated, that ozone is triatomic oxygen, necessarily involved the assumption of such a corresponding difference in density, and other physical properties,—differences admitting of exact quantitative proof or disproof. Such were the experimental difficulties in the way, however, that it was not until 1860 that an investigation was made into the volumetric relations of ozone to oxygen. The experiments of Professors Andrews and Tait then resulted in establishing that when perfectly pure and dry oxygen is converted into ozone, under the influence of the silent electric discharge, it becomes more dense, the amount of contraction being proportional to the quantity of ozone produced; also that when ozone thus condensed is exposed for a short time to a temperature of 270° to 300° it expands to its original volume. That the increase in density was exactly proportional to the amount of ozone formed was proven by an analysis of the contracted gas by means of potassium iodide. The amount of iodine in every case set free was precisely equivalent to the weight of a volume of oxygen equivalent to the volume of the contraction which the oxygen had experienced in the process of ozonation. The same laws were demonstrated to hold good with regard to electrolytic ozone, not only by these authors (1860), but also by Von Babo and Claus and by Soret (1863).

Andrews and Tait found great difficulty in reconciling the theory of the allotropism of ozone with their experiments, inasmuch as the oxidation of a body like mercury, potassium iodide, &c., was effected without any diminution in the volume of the contracted gas. In other words, the density of the allotropic oxygen concerned in this oxidation was apparently infinite. They sought therefore to explain the origin of ozone by the assumption of a decomposition of the oxygen.

But in 1861 Odling put forth the interpretation that ozone was a compound of oxygen with oxygen, the combination being attended by a contraction. Hence if one portion of the combined or contracted oxygen were absorbed by an oxidisable body, the other portion would be set free, and by its liberation might expand to the initial volume. He likewise suggested that this contraction might consist in the condensation of three volumes of oxygen into two volumes, not because this ratio was the only one which would explain the volume and density relations, so far as then known, but because, on the hypothesis of the dual nature of oxygen, this was their simplest possible explanation. Four years later Soret discovered that a very remarkable reaction occurs when electrolytic ozone is allowed to act upon oil of turpentine. Its volume is diminished by a volume equivalent to twice that of the oxygen, corresponding to the iodine set free on passing the ozonised oxygen into a solution of iodide of potassium. The latter, it will be remembered, is the same as the diminution in volume which the oxygen undergoes in ozonation, and may be called the contraction-volume. Hence the two volumes of ozonised oxygen absorbed in Soret's experiments contained not only their own volume of oxygen, but that contained in the contraction-volume, or in all three volumes of ordinary oxygen. The density of ozone, therefore, was to the density of oxygen as three to two, or 1·6584, the density of ordinary oxygen being 1·1056.

Soret inferred rather than demonstrated these relations, inasmuch as in his first set of five experiments the ratio of the total volume of ozonised oxygen absorbed by the turpentine to the contraction-volume was 2·4, and in his second set of seven experiments 1·81, both of these results being far from 2, the theoretical number.

However, in 1872, Sir Benjamin Brodie, by the introduction of methods of exact volumetric character, supplied a rigorous experimental demonstration. He obtained in a set of eight concordant experiments made with oil of turpentine, for the ratio between the whole diminution in the volume of the original oxygen, to the diminution in the volume of the ozonised oxygen, as a mean result, 3·02 to 2·02. Operating in the same manner with a neutral or slightly alkaline solution of sodium hyposulphite, he obtained, as a mean result of twenty-seven concordant experiments, the same ratio of 3·02 to 2·02. In these experiments the actual weight of the oxygen absorbed could not be determined otherwise than by calculation from the alteration in volume. But by the oxidation of stannous chloride, under proper conditions, he effected a direct determination, and found that the weight of the oxygen absorbed from the ozonised oxygen by the stannous chloride was almost exactly three times the weight absorbed from the same gas by potassium iodide. At the same time, the volume in the first case was almost exactly twice the contraction-volume, as determined by the latter reagent.—*The Journal of Science.*

Rapid Alcoholic Fermentation.—Before determining the glycerin in certain wines it has been found necessary to destroy the sugar by dilution with water and the repeated addition of yeast. M. Jos. Boussingault states, however, that by means of a process not here described, the sugar cannot be converted into alcohol within five or six hours.—*Les Mondes.*

ON THE COMPOSITION AND ANALYSIS OF WELDON MUD.

By Dr. LUNGE,
Professor at the Federal Polytechnicum, Zurich.

(Concluded from page 130.)

A second question is the *estimation of total manganese*. The last year or two have brought us quite a number of new processes for estimating Mn, principally called into life by the importance of determining the proportion of metal in iron ores, spiegeleisen, ferro-manganese, &c. Among these I will only quote the processes of Guyard as modified by Stingl and Morawski, and later on by Volhard; of Beilstein and Jawein, and of your fellow townsman, Mr. John Pattinson—leaving out a number of others which I did not think it worth my while to try. It was the question, whether the plan proposed by Mr. Weldon himself was sufficiently exact, or whether it could be replaced by any of the others with advantage?

First of all I tried Volhard's process (of which a sufficiently detailed description is given in the Chemical News, vol. xl., p. 207). 5 c.c. mud was dissolved in HCl; the solution evaporated several times with nitric acid, neutralised with soda, just acidulated with nitric acid, and titrated in the boiling state with potassium permanganate, after having added 2 grms. of pure zinc sulphate. There was used 21·3 c.c. of semi-normal permanganate, from which we find the proportion of Mn = 0·1757 grm.

A second sample of 5 c.c. treated in the same way, but leaving out the $ZnSO_4$, required 21·4 c.c. permanganate = 0 1765 Mn. That the precipitate really contained, as required by theory, pure MnO_2, without any MnO, was proved by dissolving it in ferrous sulphate solution and re-titrating; the ferrous sulphate destroyed was found to correspond again exactly to 21·4 c.c. permanganate. The first titration (according to Volhard) is represented by the equation:—

$$3MnO + 2KMnO_4 = K_2O + 5MnO_2.$$

The second by the following two equations:—

$$5MnO_2 + 10FeO = 5MnO + 5Fe_2O_3.$$
$$5Fe_2O_3 + 2MnO + K_2O = 10FeO + 2KMnO_4.$$

It is no matter of surprise that the process yields the same results with or without zinc sulphate, since the large quantity of calcium salt present plays the same part as the zinc salt, viz., supplying the "base," which seems required to secure the precipitation of *all* Mn as MnO_2. That this is possible appears from Volhard's original paper (*Annalen der Chemie*, vol. cxcviii., p. 318), and is in any case proved by the experiments just quoted.

Volhard's process is undoubtedly quite accurate, and, if the Mn is present as nitrate or sulphate, is not at all so troublesome as appears at first. The precipitate, which at first is very voluminous, later on settles down very quickly, and admits of pretty rapid titration. Still that operation (which has to be performed at nearly boiling heat) is not so easy or convenient as the iron method, and the worst feature for our purpose is the absolute necessity of destroying all chlorides, which takes a little time and trouble. I should not therefore recommend this process so much as the bleaching-powder, which is equally accurate and less troublesome.

I further tried Beilstein and Jawein's process (*Berliner Berichte*, vol. xii., p. 1528), which is principally recommended for separating Mn from other metals, and which I find to be most suitable for this purpose, when alkaline salts need not be looked for, and when there is but little iron present, both of which conditions exist in Weldon mud. Here also the chlorides must be destroyed by heating with strong nitric acid, of which there must be a large excess; then chlorate of potash is added little by little, always boiling, by which all Mn is precipitated as MnO_2, quite free from lime, &c. A portion of the clear quid is poured off and boiled with more nitric acid and potassium chlorate, which should not produce any further precipitate. The whole is diluted and filtered. The washed precipitate, if there be much iron present, contains iron, and must be again subjected to the former treatment; but, in case of very little iron being present, is practically pure MnO_2. Beilstein estimates the Mn by titrating the washed precipitate according to Bunsen's iodometrical method; but this would be very inconvenient, as it is rather troublesome to get the precipitate from the filter into the dissolving flask, and as some portions of it obstinately adhere to the beaker in which the precipitation has taken place. I have therefore modified this method in this way:—I wash the precipitating beaker as well as possible, leaving the adhering MnO_2, and put it aside. The precipitate is washed on the filter with boiling water, which is done with great ease and rapidity, as it is very dense, and occupies only a small portion of the space which the same quantity of MnO_2 requires when produced by Volhard's or the bleaching-powder method. It is, moreover, distinguished from these latter precipitates by its intensely black colour, and, more essentially, by its freedom from lime, &c., which I proved by direct analysis. The washed filter is bodily transferred into the precipitating beaker, and ferrous sulphate is added, which dissolves the precipitate, also that adhering to the glass, quite as quickly as any other precipitated MnO_2. The operation is ended by re-titrating with potassium permanganate.

Although the results of this process are quite accurate, and agree both among each other and with those of the other processes, I would recommend it only for the case (which does not occur in ordinary factory work) where CaO and MgO have to be estimated. In this case the bleaching-powder method is of course not applicable, neither is Volhard's method, which pre-supposes the precipitation of calcium or zinc oxide along with MnO_2. But for ordinary estimations of Mn, at any rate in Weldon mud, Beilstein's method is still too troublesome, as it involves as much boiling with nitric acid as Volhard's, and as it happens sometimes, if the boiling has not lasted long enough, that the liquid is after all blackened again by potassium chlorate, thus spoiling the test.

We thus come back to the bleaching-powder test, which was originally prescribed by Mr. Weldon. Mr. John Pattinson has shown quite lately, as you all know, that from a solution of a pure manganese salt there is precipitated by bleaching-powder, not pure MnO_2, but an oxide containing only 98 to 99 per cent of MnO_2, with a little MnO. He therefore prescribes the addition of ferric or zinc chloride, when pure MnO_2 falls down. This observation agrees completely with that made by Volhard, viz., that some other base must be present to satisfy the acid properties of MnO_2, failing which this is done by some MnO. But in our Weldon mud it is not even necessary to add the salts mentioned by Mr. Pattinson, for there is always quite a sufficient quantity of calcium chloride present to satisfy the requirements of the case; and we may assume from the outset that Mr. Weldon's prescription *as it stands* will give perfectly correct results. I have therefore directed my experiments to this line: to find out how far the process would be simplified without taking away from its accuracy.

5 c.c. of some fresh Weldon mud was dissolved over the lamp in as little HCl as possible, cooled down a little, a quantity of strong clear bleaching-powder solution was added, and then so much hot water that the volume amounted to 100 c.c. This mixture was heated a little longer (if filtered at once, it was sometimes found that the filtrate contained manganese); the precipitate was then filtered, thoroughly washed till KI gave no reaction, the filter put back into the first beaker, iron solution added, and titrated with iron and permanganate. Two experiments indicated the Mn to be equivalent to 8·4—8·4 c.c. semi-normal permanganate.

A third experiment was made with mud *without dis-*

solving it in acid. The mud was boiled a very short time with bleach solution as it was. The liquid turned strongly pink, and was therefore boiled for a minute with a few drops of nitric acid and alcohol, which decolourised it. The washed precipitate was found equal to 8·4 c.c. permanganate, like the first two.

A fourth experiment was made, adding to the mud some HCl, but not sufficient to dissolve it completely; undoubtedly the "base" would be saturated. The solution, boiled with bleach liquor, turned strongly red, and was decolourised by boiling with alcohol; but the first time the experiment miscarried, since the filtrate turned brown on adding more bleach, which proves that even a strong pink colour does not secure complete peroxidation unless the liquid is tried with more bleach, to see whether all MnO_2 is precipitated. On repeating the experiment with that precaution, the same result was obtained as before, viz., 8·4 c.c. permanganate.

Lastly, 5 c.c. was supersaturated with HCl, bleach liquor, water, and calcium carbonate added, just as prescribed by Mr. Pattinson. Result of *two* testings again: 8·4 c.c.

The conclusion is that in any case the same result is obtained, so that the mud need not be dissolved in acid at all, but may be boiled directly with bleach liquor. If it is proposed to dissolve it in acid, the excess of this is certainly best taken away by $CaCO_3$, to avoid a great waste of bleach and evolution of chlorine. In any case the bleach process is so simple, rapid, and accurate, that I cannot hesitate to recommend it whenever it is applicable; certainly always for Weldon mud.

We now come to the estimation of the "base." Dr. Post, in the papers quoted above, altogether denies the existence of that base, and manganites generally, in Weldon mud, from the result of a number of analyses of the mud. But that part of his paper is very open to criticism indeed. He unfortunately prepared the material for his analyses by washing the mud with an enormous quantity of water, viz., by more than 100 washings with forty times its weight of water. Even then he found the washings to contain some calcium, sulphuric acid, and very little chlorine; and he concludes from this that the calcium cannot be in chemical combination with MnO_2, whilst I for my part would just draw the opposite conclusion, viz., that there is a combination, which is gradually destroyed by the enormous mass of water. It is very probable that the water contained enough carbonic acid to convert some of the calcium into bicarbonate, and remove it as such. He found, indeed, 2·3 per cent of CO_2 in the partly-dried residue, and assumes that the CaO and MgO found by him are simply carbonates, produced by the carbonic acid present in the air blown through the oxidiser. But even according to his own analyses (which do not agree very closely among each other), the CO_2 present would not account for much more than one-third of the CaO and MgO, for which he adduces no valid reason whatever; and I cannot in any case acknowledge that he was dealing with real Weldon mud, but only with a product obtained from this, but modified by treatment with more than 4000 times its weight of water, whose gaseous and other impurities, let them be ever so small, would be very efficient owing to its enormous quantity. It is not very wonderful, accordingly, that the compound or mixture which he ultimately subjected to analysis, after having given up the attempt to reduce it to a definite state of dryness, &c., should yield somewhat less than the base required by Weldon's formula, $RO,2MnO_2$. It would be infinitely more wonderful if the thousands and thousands of testings made at the works, which always yield *more* than the above base, were altogether wrong. The only, although very remote, possibility of this would exist, if the testing method for base, generally employed at alkali works from Weldon's prescription, were entirely faulty, and to investigate this has been the last portion of my present task.

The Weldon mud which I employed for my analysis came from a small factory where they used a good deal of native manganese as well, and where they had had some trouble with the "blows," so that the base was rather high, and the proportion of MnO_2 to total Mn not very favourable, as appears from the analysis. This would not, however, influence the testing method. In order to see whether the usual test for base is correct or not, there was nothing left but to make a complete analysis of the mud. Warned by Dr. Post's want of success I preferred (as I should have done even without that stimulus) to analyse the mud *in toto* as it came to me from the oxidiser. By estimating all its constituents, leaving the water aside as immaterial, we must arrive at the *proportion* between MnO_2 and bases, and that is all we require in this case.

The mud was the same as used for the last estimations of total manganese; tested in the usual way it showed 0·0797 Mn to be present as MnO_2, and 0·1155 Mn altogether. The testing for base was performed on principle according to Mr. Weldon's instructions, but with a few modifications in detail. The mud, after warming it with oxalic acid, was not at once re-titrated with caustic potash or soda, because the final reaction with litmus is made somewhat uncertain by the precipitate suspended in the liquid, but the latter was filtered, the precipitate washed with hot water (which is done very quickly), and the filtrate titrated with semi-normal ammonia, which seems to answer better than potash; the latter sometimes causes a coloured precipitate, and gives uncertain results. Three tests gave exactly concordant results, from which the base could be calculated = 0·828.

The analysis of the whole mud yielded the following results for 5 c.c.:—

$MnO_2 = 0·1261$	; corresponds to	$2 \times 0·0232$ oxygen.
$MnO = 0·0462 = 0·0104$	basic oxygen.	
$CaO = 0·4326 = 0·1236$	,,	,,
$MgO = 0·0307 = 0·0123$	,,	,,
$Fe_2O_3 = 0·0025 = 0·0007$	,,	,,
0·1470		
$Cl = 0·5412 = 0·1245$	,,	,,
$CO_2 = 0·0070 = 0·0025$	,,	,,
$SO_3 = 0·0022 = 0·0004$	,,	,,
0·1274	,,	,,

This leaves a surplus of 0·0196 basic oxygen, and comparing this with the above figure of 0·0232, we find the ratio in Weldon's parlance = 0·845 base. This agrees so far with the figure found by Weldon's own process, viz., 0·828, that we may assume the latter to give quite near enough results for practical requirements, although hardly absolutely correct for real chemical analysis. We must not forget that Weldon's process neglects the presence of calcium carbonate, whose proportion in Weldon mud is certainly very slight. In no case can Dr. Post's conclusion be confirmed, for whether the oxides forming the base "are present in chemical combination with MnO_2 as manganese," or not, there is at any rate enough of them present for that purpose, which is precisely what Dr. Post denies, but without sufficient reason.

Whether "manganites" exist or not is quite another question, which cannot be solved by mere analysis, and which presents great difficulties. Some weighty reasons speak for the assumption that MnO_2 itself is a compound of MnO with manganic or permanganic acids, viz., either MnO,MnO_3, or $3MnO,Mn_2O_7$. In that case the "manganites" would be basic manganates or permanganates; Weldon's "acid calcium manganates," $CaO,2MnO_2$, would be, say, CaO,MnO,MnO_3, &c. I must refrain from entering into this speculative domain at further length.

I would rather conclude with a practical remark which may be new to some of the members of the Society. It has been found at the Aussig Chemical Works (Mr. Schaffner's) that it is far from indifferent what proportion of calcium chloride is present in a manganese liquor intended to be treated by the Weldon process. Unless

there are at least 2½ equivalents of $CaCl_2$ present to each equivalent of $MnCl_2$, the blows are apt to miscarry, and especially thick batches occur more easily. Accordingly at those works the liquors are regularly tested for Mn as well as for Cl, by which means the above proportion is easily found. A short time ago I was consulted by the chemist at an alkali works, where they could not get up proper batches, all of them turning stiff. At first I advised better settling, more final liquor, less heat, more blowing, &c., but nothing did any good, till I thought of that Aussig observation, which I communicated to my correspondent. A few days later I got a most grateful letter, to say that they had taken my advice and that all their troubles were over now. This may be useful to some of our friends on Tyneside as well.

P.S.—I have just received a copy of a more extended publication by Dr. Post on the above subject. From this it appears that he employed a plan for separating manganese and lime, which has long since been shown to be faulty, viz., precipitating the former by bromine in an acetic acid solution. He now quotes one analysis of unwashed Weldon mud; but this (although he does not mention it) does not confirm his own conclusions, since the base can be calculated from it to amount to 0·61.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, March 18, 1880.

Mr. Warren De la Rue, President, in the Chair.

The following certificates were read for the first time:—J. M. Dennis, R. Grimwood, W. F. Haydon, F. B. Last, H. Liepmann, A. J. Smith, J. W. Stanley.

Prof. Tidy was then called upon to read his paper on "*River Water*." The author discusses the subject under three heads:—1. Analytical Details of River Waters. 2 The Various Sources of Impurity to which River Water is Subject, and the Means whereby Purity is maintained by Nature, or may be effected by Art. 3. The extent to which Statistics warrant us in condemning or approving the Supply of River Water for Drinking Purposes.

1. *Analytical Details of River Waters.*—River Thames:—The author gives a table showing the composition of the Thames water as supplied to the metropolis from January, 1876, to December, 1879. The details given are—Total solid matter; oxygen required to organise the organic matter; organic carbon and nitrogen, as determined by Dr. Frankland; nitrogen as nitrates and nitrites; lime, magnesia, chlorine, sulphuric anhydride; hardness before and after boiling. The solid matter is at its highest in February, 21·63 grains per gallon, descending regularly to August, 18·24 grains per gallon, whence it again rises. Boiling reduces the hardness to less than one-third. From September to January the chlorine is under 1 grain per gallon; from February to August it is over 1 grain per gallon. The quantity of solid matter is no gauge as to its organic purity, as judged by the oxygen required. The testimony of the results obtained with the oxygen process agree remarkably with those obtained by the combustion process, as has already been pointed out by the author, the same story being thus told by two absolutely independent experimental witnesses. The author regrets the frequency with which cases occur where conclusions, of great importance sanitarily, are based on experimental determinations, as incapable of arrangement or of interpretation as they are outside the sphere of scientific accuracy. The nitrates or nitrites do not accord with the results indicating the organic matter; it may be that the organic nitrogen of one month becomes the organic nitrogen of the next. The author has estimated the gases dissolved in filtered Thames water on twenty-seven different occasions. The oxygen in solution during the winter months (2·19 cubic inches per gallon) was found to be very nearly double the amount held in solution during the summer months (1·19). The author intends to turn his attention to a further examination of this part of the subject. Some analyses of unfiltered Thames water from Hampton are then given. River Lea:—Monthly analyses (1877 to 1879 inclusive) of the water from this river are given. The total solid matter is again highest in February, 23·34 grains per gallon, sinking to a minimum in September, 17·99 grains per gallon. The chlorine is slightly higher than in the Thames. As far as organic matter is concerned this river is slightly purer than the Thames. The results of the oxygen and combustion processes again exhibit a remarkable correspondence. River Nile:—Monthly analyses of this river, taken during one year at Cairo, are given. The total solid matter ranged from 9·5 to 14·3 grains per gallon; the chlorine from 0·145 to 1·395; the oxygen required from 0·08 to 0·27. All the samples but that of May were thick. During April, May, and June, when the Nile is lowest, the water is worst. As regards total solid matter, 12·73 to 14·33; chlorine, 0·64 to 1·39, &c.; the month of July is the transition month, the river rapidly rising; during September and October the condition of maximum flood persists; during the fall the river attains its maximum purity. The Severn:—Analyses of samples of water collected from the Severn at various spots, in January, 1878, from Worcester above the sewage outfall down to Tewkesbury, a distance of 16 miles, together with analyses of the River Teme, are given. The Severn water contains about 16 grains of solid matter per gallon, the chlorine being double the amount of that present in the Thames. The quantity of chlorine varies remarkably at different spots, probably from the influx of brine springs from the New Red Sandstone. The Shannon:—The samples were collected in October, 1879, the river being about 2 feet above summer level. This river was selected because it drains a larger area than any single river of the British islands; because, though uncontaminated with animal impurity, it contains a large quantity of dissolved peaty matter; and because it is a type of the Irish rivers which so often pass through lakes in their course to the sea. The analyses include samples taken at the extreme ends of one of the lakes, Loch Derg. The solid matter varied from 15·3 to 20·2 grains per gallon; there was but a trace of nitrogen as nitric acid; the chlorine was remarkably constant, about 1·0 grain per gallon.

2. *The Various Sources of Impurity to which River Water is Subject, and the Means whereby Purity is maintained by Nature or may be effected by Art.*—The pollution produced by trade refuse is not considered in the present paper. Flood Water:—During the first few days of a flood the drainage called by the author "primary flood water" materially affects the river for the worse, as all the soluble and some of the insoluble matters accumulated in the soil during the period when the rainfall was insignificant pass into the river. The river becomes heavy in total solid matter, excessive in dissolved organic matter, and turbid. The velocity of the river is increased, and carries down accumulations, organic and mineral, from the higher reaches of the river. The author then gives analyses of the Thames water before and after two heavy floods (November 18th, 1875, and January 11th, 1877); the rise in the total solid matter is not so great as was expected; the rise in the organic matter was well marked, the high flood water requiring 0·173 grain of oxygen per gallon against 0·064 grain ten days before; further analyses of ordinary floods are given, which show similar results. Primary flood water is therefore inferior to normal river water as regards organic purity and general clearness. By "secondary flood water" the author implies the water that comes down after some considerable period of flood, when the drainage area has been washed clean, the river passing slowly from a state of maximum impurity to one of maximum purity; the total solid matter of a secondary

flood water being only 17·28 grains against 22·84 grains in primary flood water, the oxygen required being reduced to about a sixth, the hardness by 3 degrees, whilst the suspended matters are too small to be capable of estimation. Although the Thames when at or below summer level is brighter and clearer than at any other time, the water is not of such good quality as during the period succeeding a flood. The author then discusses the influence of floods as exhibited in the River Nile, and shown in the analyses already referred to; the influence of the geological nature of the drainage area; of the time of year at which the floods occur; of the interval between one flood and the next; and of the exact time occupied by a given rainfall on the flood water carried into the river. He then takes up the subject of peat. Peat exists for the water analyst as old peat or recent peat, the latter giving a yellowish green, the former a coffee-brown tint, the colour passing through all gradations according to the age and quantity of peat present. The author then insisted on the value of the "two-foot tube," *i.e.*, a tube 2 feet long, 2 inches in diameter, with white glass ends, as a most valuable adjunct to analysis: thus 0·4 per 100,000 of organic carbon would have a very different significance to the chemist if the tint exhibited by a large bulk of the water was brown, indicating vegetable matter, to what it would if the water was colourless. Prof. Tidy has never known in practice a case where the water of a river became colourless simply through the bleaching of peat, and thinks that it is quite possible to compare the depths of colour in two waters, though the tints are different. The oxidation of peat has been carefully studied by the author; in the Shannon he has analysed the water at various places, the most notable instance of oxidation being at the falls of Castle Connell; a short distance above, the organic carbon being 0·84 part per 100,000; a short distance below, 0·593 per 100,000. Another instance of this diminution of carbon was noticed in the North of England, where the water is peaty, and is delivered from a storage reservoir to the supply reservoir, 6820 yards distant, by two channels,—one a closed iron pipe, the other an open brick conduit. The water delivered by the iron pipe has distinctly a peaty tint; the same water delivered from the conduit is clear and nearly colourless. The water in the storage reservoir contained 0·46 organic carbon per 100,000; that from the iron pipe, 0·49; that from the open conduit, 0·23. This, says the author, is a perfect experimental proof of the oxidation of peat. The quantity of peat can also be considerably reduced by admixture with water containing much suspended mineral matter, which causes a precipitation of the peat. Thus the entrance of the turbid River Mulcaire brings down the organic carbon in the Shannon from 0·914 to 0·61. This action was also confirmed by shaking up a peaty water with turbid Mulcaire water in the laboratory. Thus the quantity of peat in running water is kept in check—(1) by the inherent power which water possesses of self-purification, owing to the oxidation of the peat by the oxygen held in solution in the water, the process being enormously helped by certain natural and physical conditions, whereby the more complete aëration of the water and the intimate contact between the oxygen and peat is effected; (2) by mechanical precipitation, by admixture with coarse mineral suspended matter. From peat the author passes to animal impurity: he agrees entirely with Dr. Frankland as to the vital importance of this subject. No one, says Prof. Tidy, should be required to drink his own excreta, much less the excreta of his neighbours. The two important questions are—Does the water of a river, having been once polluted by admixture with sewage, again, after a moderate flow, assume its original state of purity? And, secondly, If such a natural process of self-purification exists, what are the conditions requisite for its fulfilment, and what are the circumstances affecting these conditions? The author answers the first question in the affirmative, and considers that this self-purification depends upon three things:—(*a*) the subsidence of the coarser suspended impurities; (*b*) the presence of animal life after the water has assumed a certain degree of purity; (*c*) the oxidation of the organic matter, the dissolved oxygen being derived partly from the air and partly from plant life. The rapidity of this oxidation depends on the degree of dilution of the sewage, the distance of run, the velocity of the current, the temperature, and certain natural or artificial physical conditions, such as the mixing of the water and air at locks, weirs, &c. The author then proceeds to enumerate the proofs of this oxidation. From analogy we should expect water to purify itself, as the air, which is constantly receiving masses of organic *débris*, eliminates. by oxidation, &c., its sewage matter. Are men never to drink water because it has once been contaminated by sewage? As well might we say that air which has once received scales from a person suffering from scarlet fever, or the infected breath of a measly patient, must never be breathed again. If oxidation purifies in the one case, may not oxidation be expected to act in the other? The proofs of this oxidation are threefold:—(A.) The naked-eye inspection of rivers receiving sewage. The sewage at the outfall is probably offensive; as it passes down the river it blackens from the formation of sulphide of iron; farther on this black colour decreases, disappears, and the river at last exhibits no signs of odour, colour, or turbidity. Again, soon after the sewage has been turned into the river, the sewage fungus appears, all other vegetable life being absent, no fish are seen, the banks are black; a short distance farther on the fungus vanishes, vegetation is luxuriant, fish abound, the river clears, and no trace of black deposit can be seen. Thus the River Soar, at Leicester, is black with sewage; at Loughborough, 13 miles distant, the river is perfectly clear, and fish are abundant; the Irwell, at Manchester, is polluted with every form of filth—in 9 miles the offensive character of the stream has entirely disappeared; and so on in many more cases. Such examples prove the power of self-purification possessed by rivers. (B). Analysis. The Thames at Lechlade may be taken as pure river water; after flowing a distance of 110 miles, and receiving the sewage of many towns, &c., the water at Hampton contains rather less organic carbon and nitrogen that at Lechlade. What has become of this sewage if it has not been oxidised? The same is true of many other rivers—the Severn, the Wear, &c. The author then refers to the diametrically opposite conclusions in the Sixth Report of the Rivers' Commission, in which Dr. Frankland states that organic matter is not appreciably oxidised by the flow of a few miles. Prof. Tidy does not for one moment question the accuracy of the results, but strongly dissents from the conclusions, and submits that analyses indicating a *reduction* of organic carbon and nitrogen between two spots are of much greater value than any analyses indicating the reverse; because Dr. Frankland cannot say that the organic matter found at B, where he collected his second sample, is the same as that found at A, where the first sample was taken, and between the two spots, A and B, a fresh quantity of organic matter may have been introduced. Thus, to take an illustration—Six passengers enter a carriage at station No. 1; at station No. 3, six passengers are still in the carriage, but unless there is evidence to show that they are the *same* six passengers there is nothing to prove that the whole of the six passengers who got in at station 1 did not get out at station 2 and six fresh passengers get in. But if, at station 3, only two passengers are found, it is absolutely certain that at least four must have got out at station 2. The author then criticises experiments in which Dr. Frankland shook up a mixture of water with 10 per cent of sewage, and thus imitated the flow of a polluted stream for 96 and 192 miles. The author contends that these experiments did not imitate at all accurately the flow of a stream, and the results obtained are therefore valueless. The author set up an apparatus which did to some extent represent the action of a running stream. It consisted essentially of a series of about 20 V-shaped wooden

troughs lined with glass: the troughs were placed one over the other, and were inclined alternately in opposite directions, so that the water flowed from a cistern into the upper trough, and thence gradually down the 20 troughs into a cistern beneath, from which it was pumped up into the higher cistern. After many difficulties, from the smoky atmosphere in London, the author, with the assistance of Mr. Hart, obtained results with various mixtures of New River water with sewage from Abbey Mills, which proved satisfactorily a decided decrease of organic matter after a run of 1 mile. After 2 or 3 runs the offensive sewage smell disappeared; the last traces of sewage matter seem to be the most difficult to oxidise. From these considerations the author concludes by thus paraphrasing a well-known passage in the "Sixth Report of the Rivers' Commission," p. 138. "I am led to the inevitable conclusion that the oxidation of the organic matter in sewage, when mixed with unpolluted water and allowed a certain flow, proceeds with extreme rapidity, and that it is impossible to say how short a distance such a mixture need flow under favourable conditions before the sewage matter becomes thoroughly oxidised. It is certain to my mind that there is no river in the United Kingdom but what is many times longer than is required to effect the destruction of sewage by oxidation." Some of the methods for purifying water are then considered. A water which is impure from the presence of sewage should be unhesitatingly rejected. In urging the claims of rivers as one of the sources for water supply, the author means always rivers free from sewage, *i.e.*, rivers, the purity of which at the suggested intake can be proved by chemical analysis. Having such a water, however, much may be done by art to improve it by storage, subsidence, and filtration: these methods are considered in detail. Pure sand of uniform medium fineness is recommended as the best filtering medium on the large scale; the rate of filtration should be 2 gallons per hour per square foot; the filter bed should be changed about every two years.

3. *How far do Statistics warrant us in Condemning or in Approving the Supply of River Water for Drinking Purposes?*—In the opinion of the author, peaty waters have not been proved to produce diarrhœa. As regards animal pollution the author admits that disease has been produced by drinking impure and polluted water; but the argument against the use of a river water is based (1) on the existence of germs; (2) on the supposition that the oxidation process which might affect organic matter would probably leave organised bodies untouched. Germs would probably be destroyed by oxidation and endosmose after a run of 10 or 12 miles in a river. If they are not destroyed as organic matter they ought, as organised bodies, to increase; and as we pass down the river each town should exhibit an increasing death rate from the multiplication of the disease germs. Statistics, however, show a very different state of things. A disease usually spreads up, not down a river. From an examination of numerous statistics it is seen that the death rate of towns in which the water is obtained from wells is practically identical with that in towns supplied by rivers, and that in London, as regards mortality, there is very little to choose between districts supplied by well water and those supplied by river water; so that it is clear that the *materies morbi* is subject to the same laws of destruction as ordinary organic matter. As a matter of sentiment the author would prefer well water. If all the mischief be laid to an undiscoverable germ a terrible doubt is cast on the value of all chemical analysis. There is no well-authenticated case where river-water, having received sewage, the dilution being considerable, and circumstances favourable for oxidation, has, after a flow of 10 to 12 miles, been manifestly the cause of an outbreak of disease. In all well-proved cases of outbreaks of disease resulting from the use of drinking-water, such water would have been unhesitatingly condemned on analysis by the chemist. The author protests most strongly against the startling statement in the "Report of the Rivers' Commission," "That the supply of deep well water would confer on the metropolis *an absolute immunity* from epidemics of cholera." Regarding all the above facts, the author submits the two conclusions:—

(1.) That when sewage is discharged into running water, provided that the dilution of that sewage with pure water be sufficient, the whole of the organic impurity will be got rid of after the run of a few miles.

(2.) That facts indicate that, whatever may be the actual cause of certain diseases, the *materies morbi* that finds its way into the river at the sewage outfall is destroyed along with the organic impurity after a certain flow.

The above paper (of about 130 pages) contains a large number of tables of analyses, &c.: it was listened to with great interest by a crowded meeting of the Society.

The President said that the large assemblage that evening evinced the great interest taken by chemists in this vital question of a suitable water supply. This interest had been increased by the forcible yet courteous way in which Prof. Tidy had supported his views. He would call on Dr. Frankland for any remarks he would like to make.

Dr. Frankland said that at that late hour it was quite impossible to do justice to the discussion of this important paper. He did not know any subject of greater moment to the health of towns. He had listened to many statements founded on opinions, surmises, and casual observations, but they had made but little impression, as they lacked the quantitative element: the present paper differed entirely from such statements. Prof. Tidy had furnished us with a large number of facts which deserved serious consideration. As far as he could see there was no fundamental difference between the facts of Prof. Tidy and previous results of his own, but considerable explanation was necessary to understand how such diverse opinions could be drawn from identical facts. He would therefore propose that the discussion be deferred until after the paper had been printed.

The discussion was then adjourned *sine die*.

The cordial thanks of the meeting were given to Prof. Tidy for his paper, and the Society adjourned to April 1st, when the following papers will be read:—"On β-Orcinol," by Dr. Stenhouse and Mr. Groves; "Preliminary Note on the Action of the New Diastase, Eurotin, on Starch," by R. W. Atkinson; "Note on the Products of the Combustion of Coal-gas," by L. T. Wright; "On Polysulphide of Sodium," by H. C. Jones; "On the Reflection from Copper, and on the Colorimetric Estimation of Copper," by T. Bayley; "On Pyren," by Watson Smith and G. W. Davies; "Analyses of the Ash of the Wood of Two Varieties of the Eucalyptus," by Watson Smith.

The Anniversary Meeting takes place on Tuesday, March 30.

CORRESPONDENCE.

THE DIRECT METHOD FOR TESTING VITRIOL CHAMBER EXITS.

To the Editor of the Chemical News.

Sir,—I wish to say that on making enquiries I have satisfied myself that Mr. G. E. Davis had originated and used the method of testing the N compounds in vitriol chamber exits by the use of the nitrometer as early as September, 1878, so that I was mistaken in thinking that I used it for the first time in May, 1879.—I am, &c.,

T. E. Vasey.

Church Street Chemical Works,
Leeds, March 9, 1880.

THE DIRECT METHOD FOR TESTING VITRIOL CHAMBER EXITS.

To the Editor of the Chemical News.

Sir,—In my letter (Chemical News, vol. xli., p. 69) I did not wish to imply that Mr. Vasey had *intentionally* appropriated the method of testing vitriol chamber exit gases for nitrogen compounds by the use of my nitrometer. All I wished to do was to inform your readers that I had used and recommended it as a correct and ready method long previously.—I am, &c.,

George E. Davis.

PS.—In my letter (*ibid.*) *for* "after acidifying and evaporating," *read* "after evaporating and acidifying."

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
No. 18.

The Occurrence of Para-leucanilin in the Magenta Melt.—C. Graebe.—The author suggests that para-leucanilin is a direct product of the action of arsenic acid upon a mixture of aniline and toluydin, and that the colouring-matters may perhaps be formed by its oxidation.

Synthesis of Phenyl-naphthyl-carbazol.—C. Graebe and W. Knecht.—The authors had previously suggested that a body found in crude anthracen was to be regarded as a carbazol of the composition $C_{16}H_{11}N$, possibly an imido-phenyl-naphthalin. Their supposition has been synthetically confirmed.

Relative Replaceability of Bromine in the Mono-brom-benzyl-bromides.—C. Loring Jackson.—The bromine is most readily replaced in the para compounds, least in the ortho, the meta compounds taking an intermediate position.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.
No. 72, December, 1879.

This issue contains no chemical matter, save a paper by M. Peligot on the properties of glucose. It has been noticed under the *Comptes Rendus*.

Verhandlungen des Vereins zur Beforderung des Gewerbfleisses. No. 1, January, 1880.

This issue is exclusively taken up with mechanical subjects.

Annales de la Société des Sciences Industrielles de Lyon.
No. 3, 1879.

This issue, again, consists exclusively of mechanical matter.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 7, February 12, 1880.

The chemical matter in this number has been already noticed.

No. 8, February 19, 1880.

The Phenomena of Vision.—Prof. H. H. Dor.—The author combats the theory that our ancestors were colour blind.

The Thermo-electric Battery of M. C. Clamond.—This paper cannot be reproduced without the accompanying illustrations.

No. 9, February 26, 1880.

Carbonic Oxide in the Products of the Combustion of Coal-gas.—M. Gréhaut.—The small quantity of carbonic oxide evolved can scarcely be detected by its effects on animals compelled to inhale the products of combustion.

Temperature of the Sun.—M. Rossetti.—The author contends that the temperature of the sun does not fall below 20,000°.

Summary of Recent Progress in Chemistry.—M. Gerber.—A series of notes from papers regularly abstracted in the Chemical News.

No. 10, March 4, 1880.

Experimental Researches on Accidental Double Refraction.—M. Macé de Lépinay.—The author's researches have led to the observation of certain new facts, but they have neither supported nor destroyed the theoretical ideas by means of which Naumann has attempted to explain accidental double refraction.

Palm Oil.—An account of the source, the supply, and the uses of this oil.

Ericin, a Colour extracted from Poplar Wood.—This dye is said to be obtained by treating with a hot solution of alum the stems of common heath and the wood of different varieties of the poplar.

Reimann's Färber Zeitung,
Nos. 5, 6, and 7, 1880.

These numbers contain nothing of general interest.

NOTES AND QUERIES.

Reactions of Soluble Glass.—Would you kindly inform me what reaction takes place when pounded dolomite is mixed up with silicate of potash? I chiefly want to know whether the magnesia forms a chemical compound with the potash, which, I presume, is liberated by the carbonate of lime, or is the potash left free to come out as an efflorescence? Can you refer me to any work giving a clear account of the action of water-glass when combined with such materials as are usually mixed with it? I am told that magnesia forms an insoluble compound with water-glass, but does it do so in the same way as chloride of calcium, which, I understand, forms silicate of lime, but by so doing leaves the potash free?—L.

MEETINGS FOR THE WEEK.

Tuesday, 30th.—Civil Engineers, 8.
—— Chemical, 8. (Anniversary.)
Thursday, April 1st.—Chemical, 8. Dr. Stenhouse and C. E. Groves "On β-Orcinol." Mr. R. W. Atkinson, "Preliminary Note on the Action of the New Diastase, Eurotin, on Starch." Mr. Lewis T. Wright, "Note on the Products of Combustion of Coal Gas." Mr. H. Chapman Jones, "On Polysulphide of Sodium." Mr. Thomas Bayley "On the Reflection from Copper and on the Colorimetric Estimation of Copper." Mr. Watson Smith and George W. Davies, "On Pyrene." Mr. Watson Smith, "Analysis of the Ash of the Wood of two varieties of the Eucalyptus."
Friday, 2nd.—Geologists' Association, 8.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

Incorporated under the 30th and 31st Victoria, Chap. 131, Sec. 23, on October 2nd, 1877.

LIST of OFFICERS and COUNCIL.

President—F. A. ABEL, C.B., F.R.S., &c.

Vice-Presidents.

James Bell, F.C.S.
E. Frankland, Ph.D., D.C.L., F.R.S., &c.
W. N. Hartley, F.R.S.E., F.C.S.
E. J. Mills, D.Sc., F.R.S., &c.
T. Redwood, Ph.D., F.C.S.
H. E. Roscoe, Ph.D., F.R.S., &c.

Treasurer—C. R. Alder Wright, D.Sc., F.C.S.

Ordinary Members of Council.

John Attfield, Ph.D., F.C.S.
Dugald Campbell, F.C.S.
Michael Carteighe, F.C.S.
William Dittmar, F.R.S.E., F.C.S.
A. Dupré, Ph.D., F.R.S., F.C.S.
R. J. Friswell F.C.S.
J. H. Gladstone, Ph.D., F.R.S., &c.
George Gore, LL.D., F.R.S.
C. Graham, D.Sc., F.C.S.
P. Griess, Ph.D., F.R.S., &c.
C. W. Heaton, F.C.S.
Douglas Herman, F.C.S.
C. T. Kingzett, F.C.S.
J. W. Kynaston, F.C.S.
F. A. Manning, F.C.S.
W. Odling, M.A., M.B., F.R.S., &c.
G. H. Ogston, F.C.S.
F. J. M. Page, F.C.S.
John Pattinson, F.C.S.
J. Emerson Reynolds, M.D., M.R.I.A., F.C.S.
G. J. Snelus, F.C.S.
J. Spiller, F.C.S.
A. Norman Tate.
C. Meymott Tidy, M.B., F.C.S.
R. V. Tuson, F.C.S.
A. Voelcker, Ph.D., F.R.S., &c.
R. Warington, F.C.S.

Secretary—C. E. Groves, F.C.S.

Offices—Somerset-house-terrace, S.W.

This Institute has been established to ensure that consulting and analytical chemists are duly qualified for the proper discharge of the duties they undertake by a thorough study of chemistry and allied branches of science, in their application to the arts, public health, agriculture, and technical industry.

The Members of the Institute are divided into two grades, having the distinguishing ranks or degrees of Fellow and Associate respectively.

In the case of a Fellow, the Council of the Institute requires satisfactory evidence as to training and fitness for the work of the consulting and analytical chemist, to be produced before admitting any person to that degree, and an examination is imposed whenever the Council deems it necessary. Fellows must be at least 24 years of age.

In the case of Associates, the present regulations require every applicant for admission to this grade to submit to a stringent examination in practical chemistry, and to show to the satisfaction of the Council that he has passed through a course of three years' study of theoretical and analytical chemistry, physics, and elementary mathematics. An Associate must be at least 21 years of age before admission, and is not eligible for the higher rank of Fellow until he has been continuously engaged for three years in the study and practical work of Applied Chemistry, in a manner that shall be considered satisfactory by the Council.

FELLOWS.

Abel, F. A., C.B., F.R.S., F.C.S., Royal Arsenal, Woolwich, S.E.
Abney, Capt. W. W., F.R.S., 3, St. Alban's-road, Kensington, W.
Ackroyd, William, M.Pn.S., Wharf-street, Sowerby-bridge, Yorks
Acworth, Joseph J., F.C.S., Oakville-house, Gravesend
Adair, Alfred, Vale-view, Whitehaven
Aitkin, Andrew P., D.Sc., Edinburgh University
Allen, Alfred H., F.C.S., 2, Collegiate-crescent, Sheffield
Allison, R. E., 37, Lamb's Conduit-street, W.C.
Allison, Henry T., Thornaby Iron Works, Stockton-on-Tees
Angell, Arthur, Ph.D., 4, Portland-terrace, Southampton
Angell, John, F.C.S., Grammar School, Manchester
Appleyard, Gilbert C. W., Prestolee, near Manchester
Armstrong, H. E., Ph.D., F.R.S., London Institution, E.C.
Atkinson, Edmund, Ph.D., F.C.S., Portesbury-hill, Camberley
Atkinson, Robert William, D.Sc., F.C.S., University of Tokio, Japan
Attfield, John, Ph.D., F.C.S., 17, Bloomsbury-square, W.C.
Bannister, Richard, F.C.S., Laboratory, Somerset-house, W.C.
Barff, Frederick S., F.C.S., 100, Abbey-road, Kilburn, N.W.
Barrett, Edward Louis, B.Sc., F.C.S., 53, Springfield-road, N.W.
Bassett, Henry, F.C.S., 26, Belitha-villas, Barnsbury, N.
Baynes, James, jun., F.C.S., Kingston-upon Hull
Bean, Charles Edward, F.C.S., Brooklyn-house, Shepherd's-bush, W.
Beilby, George, Midcalder, Scotland
Bell, J. Carter, F.C.S., Assoc. R.S.M., Kersal Clough, Higher Broughton, Manchester
Bell, James, F.C.S., Laboratory, Somerset-house, W.C.
Bell, William Gomm, Assoc. R.S.M., 52, Duchess-road, Birmingham
Bickerdike, William Edward, F.C.S., Surbiton-place Blackburn
Bickerton, A.W., Christchurch, New Zealand
Bischof, Gustav, F.C.S., 4, Hart-street, Bloomsbury, W.C.
Bourcher, Charles Edward, Messrs. Birdley and Co., The Brewery, Burton-on-Trent
Bowdler, Arthur Clegg, 20, Wellington-street, Blackburn
Bowrey, James John, F.C.S., Kingston, Jamaica
Brazier, James Smith, F.C.S., University, Aberdeen
Brock, John, British Alkali Works, Widnes, Lancashire
Brodie, Sir Benjamin C., M.A., D.C.L., F.R.S., F.C.S., Brockham Warren, Surrey
Brown, A. Crum, M.D., D.Sc., F.R.S., 8, Belgrave-crescent, Edinburgh
Brown, Adrian John, F.C.S., Burton-on-Trent
Brown, Edwin Ormond, F.C.S., Royal Arsenal, Woolwich, S.E.
Brown, James Campbell, D.Sc., F.C.S., Liverpool
Brown, Horace T., F.C.S., Burton-on-Trent
Bruce, A.C., M.A., F.C.S., King Edward School, Birmingham
Buchanan, John Young, F.R.S. L., 10, Moray-place, Edinburgh
Bullock, J. Lloyd, F.C.S., 3, Hanover-street, W.
Burge, Charles H., Laboratory, Somerset-house, W.C.
Burghardt, Charles Anthony, Ph.D., Owen's College, Manchester
Butterfield, John Cope, F.C.S., 106, Queen Victoria-street, E.C.
Calderwood, John, Addiewell, West Calder, N.B.
Cameron, Charles A., M.D., F.R.S.C.I., 15, Pembroke-road, Dublin.
Cameron, James, Laboratory, Somerset-house, W.C.
Cameron, John Macdonald, F.C.S., 7, Oxford-Villas, Glenthorne-road, Hammersmith
Cammack, John, 50, Pecker's-hill, Sutton, near St. Helen's
Campbell, Dugald, F.C.S., 7, Quality-court, Chancery-lane, E.C.
Carey, Eustace, Widnes, Lancashire
Carteighe, Michael, F.C.S., 180, New Bond-street, W.
Caswell, Charles Benjamin, F.C.S., 13, George-road, Birmingham
Church, A. H., F.C.S., Royston House, Kew
Clark, John, Ph.D., F.C.S. 138, Bath-street, Glasgow
Claudet, F., F.C.S., 6 and 7, Coleman-street, E.C.
Cleaver, Edward Lawrence, F.C.S., 289a, King's-road, S.W.
Clemenshaw, Edward, F.C.S., Greenhill, Sherborne
Cloud, Thomas Charles, Assoc. R.S.M., Wallaroo, South Australia
Clowes, Frank, D.Sc., F.C.S., Newcastle-under-Lyme
Coleman, Joseph James, F.C.S., 45, West Nile-Street, Glasgow
Cooke, Samuel, M.A., Civil Engineering College, Poona, India
Coomber, Thomas, F.C.S., 80, Kingsdown-parade, Bristol
Corfield, W. H., M.A., M.B., F.C.S., 10, Bolton-row, Mayfair, W.
Cownley, Alfred John, F.C.S., 106, Fenchurch-street, E.C.
Cranston, George, Messrs. Storer and Sons, Sydney-street, Glasgow
Criper, W. R., Assoc. R.S.M., 85, St. John-street, E.C.
Crookes, William, F.R.S., F.C.S., 20, Mornington-road, N.W.
Crowder, William, Evering-road, Upper Clapton, E.
Dalziel, John Graham, F.R.S.E., United College, St. Andrew's, N.B.
Darby, Stephen, F.C.S., 140, Leadenhall-street
Darling, William Howard, F.C.S., 126, Oxford-street, Manchester
Davies, Edward, F.C.S., Royal Institution, Liverpool
Davies, R. Higgins, F.C.S., Rutland-road, Hammersmith, W.
Davis, G. E., F.C.S., Dagmar-villa, Heaton Chapel, near Stockport
Davis, Henry Wilson, Laboratory, Somerset-house, W.C.
Day, James John, 18, London-street, Derby
Deacon, Henry Wade, Appleton-house, Widnes
De Chaumont, Francis, S.B.F., M.D., Army Medical School, Netley
De la Rue, Warren, D.C.L., F.R.S., F.C.S., 73, Portland-place, W.
Dent, William Y., F.C.S., Royal Arsenal, Woolwich, S.E.
Dewar, James, F.R.S., Cambridge
Dittmar, W., Anderson's College, Glasgow
Divers, E., M.D., F.C.S., Yokohama, Japan
Dixon, William A., F.C.S., Laboratory, School of Arts, Sydney
Dodd, Thomas Henry, F.C.S., Las Minas de Rio Tinto, Rio Tinto, Huelva, Spain
Donkin, W. F., M.A., F.C.S., University Museum, Oxford
Dougal, Samuel S., Glenpark-villa, Busby, near Glasgow
Downar, George Frederick, 1, Chapel-road, Bexley-heath, Kent
Dreyfus, Charles, 7, Chapel-walks, Manchester
Duncan, James, F.C.S., 71, Cromwell-road, S.W.
Dupré, Auguste, Ph.D., F.R.S., Westminster Hospital, S.W.
Early, William, Trinity College, Dublin
Elcott, Thomas, F.C.S., 55, Torriano avenue, Camden-road, N.W.
Estcourt, Charles, F.C.S., St James's-square, Manchester
Evershed, Frank, 8, Dalrymple-terrace, Glenarm-road, Clapton, E.
Fairley, Thomas, F.R.S.E., F.C.S., 16, East-parade, Leeds
Farries, Thomas, F.C.S., 16, Coleman-street, E.C.
Fenton, Henry J. H., Christ's College, Cambridge
Ferguson, John, M.A., F.C.S., University, Glasgow
Ferguson, W. B., M.A., 2, Penbarn-terrace, Moss-lane East, Manchester
Field, Frederick, F.R.S., F.C.S. Upper Marsh, Lambeth, S.E.
Foord, George, F.C.S., Royal Mint, Melbourne
Foster, William, B.A., F.C.S., Middlesex Hospital, W.
Francis, Ernest E. H., F.C.S., George Town, Demerara
Frankland, E., D.C.L., F.R.S., F.C.S., Royal College of Chemistry, South Kensington Museum, S.W.
Friswell, R. J., F.C.S., 10, Clapton-square, E.
Fuller, W. J., F.C.S., The Retreat, Sutton, Surrey
Gale, Samuel, F.C.S., 338, Oxford Street, W.
Galloway, Robert F.C.S., M.R.I.A., 47, Leeson-park, Dublin
Gardner, John, F.C.S., 11, St. Paul's-crescent, Camden-square, N.W.
Garrick, Andrew R., Ph.D., St. Helens, Lancashire
Gatehouse, James Wright, 36, Broad-street, Bath
Gilbert, John Henry, Ph.D., F.R.S., F.C.S., Harpenden, St. Alban's
Gilchrist, Percy C., F.C.S., Assoc. R.S.M., Blaenavon, Monmouthshire
Gladstone, J. H., Ph.D., F.R.S., F.C.S., 17, Pembridge-square, Hyde-park, W.
Glover, G. T., F.C.S., 30, Donegall-place, Belfast
Gordon, Joseph Gordon, F.C.S., 20, King-street, S.W.
Gore, George, LL.D., F.R.S., Islington-row, Edgbaston, Birmingham
Graham, A. McDonald, F.C.S., 38, Albany street, North Leith, Edinburgh
Graham, Charles, D.Sc., F.C.S., University College, W.
Greenaway, A. J., F.C.S., 11, Pemberton-gardens, Upper Holloway, N.
Greenway, Thomas, The Sheffield Smelting Company, Sheffield
Gregory, Henry Richard, 7, Quality-court, Chancery-lane, E.C.
Greville, Henry Leicester, F.C.S., 4, Moreland-villas, Lambeth-road, Hornsey-rise

Griess, Peter, Ph.D., F.R.S., F.C.S., Burton-on-Trent
Grosjean, B. J., F.C.S., Messrs. Lawes' Chemical Works, Millwall, E.
Groves, Charles Edward, F.C.S., Somerset-house-terrace, W.C.
Gurney, H. S. Lewis, Wilderspool, Warrington.
Hake, Henry Wilson, Ph.D., F.C.S., Carlton-chambers, 12, Regent-street, S.W.
Halse, William Edward, F.C.S., 21, Mincing-lane, E.C.
Hanbury, Cornelius, F.C.S., Plough-court, E.C.
Hannay, J. B., F.C.S., Sword-street, Glasgow
Harkness, William, F.C.S., Laboratory, Somerset-house, W.C.
Hartley, W. Noel, F.R.S.E., F.C.S., College of Science, Stephen's-green, Dublin
Hastings, H. Mitchell, F.C.S., 54, Edith-road, The Cedars, West Kensington, W.
Heaton, Charles William, F.C.S., Charing-cross Hospital, W.C.
Heddle, Matthew Forster, M.D., F.R.S.E., St. Andrews, Scotland
Hehner, Otto, F.C.S., 54, Holborn Viaduct, E.C.
Helm, Henry James, F.C.S., Laboratory, Somerset-house, W.C.
Henry, William Charles, M.D., F.R.S., F.C.S., Haffield, near Ledbury
Herman, Douglas, F.C.S., Cropper's-hill, St. Helen's, Lancashire
Hewitt, David B., Beech-house, Prestwich, Radcliffe, near Manchester
Hibbert, Walter, F.C.S., 2a, Chapel-street, Edgware-road, W.
Higgin, James, F.C.S., Woodhey, Kersal, Manchester
Hill, Alfred, M.D., F.C.S., Birmingham
Hill, A. Bostock, M.D., Unity-buildings, Temple-street, Birmingham
Hills, Thomas Hyde, F.C.S., 338, Oxford-street, W.
Hodges, Frederick, Queen's College, Belfast
Hodges, John Frederick, M.D., F.C.S., Queen's College, Belfast
Hodgkinson, W.R., Ph.D., Newark House, Warbeck Road, Shepherds Bush W.
Hoffman, G.C., 76, St. Gabriel-street, Montreal, Canada
Holmes, John, Laboratory, Somerset-house, W.C.
Hopwood, George Manley, F.C.S., Department of Agriculture, Melbourne
Howard, David, F.C.S., Rectory Manor, Walthamstow, E.
Howard, Thomas, F.C.S., 52, Swinton-street, Gray's-inn-road, W.C.
Howard, William Dilworth, Stratford, E.
Hughes, John, 79, Mark-lane, E.C.
Humpidge, T. S., Ph.D., B.Sc., University College, Aberystwyth
Huntington, Alfred Kirby, Assoc. R.S.M., Abbeville-house, Green-hill, Hampstead, N.
Hurter, Ferdinand, Ph.D., Widnes
Huskisson, Henry Owen, F.C.S., 42, Highbury-park, N.
Huson, C. W., B.Sc., 5, York-buildings, Dale-street, Liverpool
Hutchings, W. M., Rock Lea, Mount Pleasant-road, Liscard, Birkenhead
Huxley, J. H., Assoc. R.S.M., Crescent-road, Sharrow, Sheffield
Ivey, W. E., Canterbury College, Christchurch, New Zealand
Jackson, Edgar, Assoc. R.S.M., 106, Queen Victoria-street, E.C.
Japp, Francis Robert, M.A., Ph.D., F.C.S., 27, Woodstock-road, Bedford-park, Turnham-green
Jarmain, George, F.C.S., 84, Northgate, Huddersfield
Johnson, George Stillingfleet, F.C.S., 11, Savile-row, W.
Johnson, Thomas H., F.C.S., 96, Duke-street, Liverpool
Johnstone, W., Athenæum-chambers, King's Lynn
Jones, E. W. T., F.C.S., Wolverhampton
Jones, Francis, F.R.S.E., F.C.S., Grammar School, Manchester
Jones, H. Chapman, 106, Blackstock-road, Highbury, N.
Keates, Thomas William, 10, Spring-gardens, W.
Keene, James Boddely, 38, Hartham-road, Camden-road, N.
Keightley, Alfred Dudley, F.C.S., Old-hall, Milnthorpe
Kellner, William, Ph.D., F.C.S., Royal Arsenal, Woolwich, S.E.
Kendall, James Alfred, F.C.S., Silvertown, E.
Kinch, Edward, F.C.S., Tokio, Japan
King, John Falconer, F.C.S., Edinburgh
Kingzett, Charles T., F.C.S., 12, Auriol-road, The Cedars Estate, West Kensington, W.
Kitchin, Archibald, F.C.S., 27, King-street, Whitehaven
Kynaston, Josiah W., F.C.S., St. Helens
Lawes, John Bennet, F.R.S., F.C.S., Rothamstead, St. Alban's
Lawson, G., LL.D., Dalhousie College, Halifax, Nova Scotia
Leebody, J. Robinson, M.A. Magee College, Londonderry
Letts, Edmund Albert, Queen's College, Belfast
Lewin, George, Laboratory, Somerset-house, W.C.
Liveing, George Downing, M.A., F.C.S., Cambridge
Liversedge, A., Assoc. R.S.M., University, Sydney
Lloyd, F. J., F.C.S., 16, Barbara-terrace, Barnsbury, N.
Lott, F. E. Assoc. R.S.M., Stapenhill, Burton-on-Trent.
Loram, Herbert Y., F.C.S., 46, Lennfield-road, Fern Tower-road, Highbury New-park, N.
Louis, H., Assoc. R.S.M., Derwent-house, Derwent-road, Anerley, S.E.
Lovett, W. J., Victoria Chemical Works, Bradford, near Manchester
Low, Alfred John George, 167, Fenchurch-street, E.C.
Lowe, W. Foulkes, F.C.S., Assoc. R.S.M., Cambrian View, Chester
Luff, A. P., 13, Lisson-street Marylebone-road, N.W.
Lupton, Sidney, F.C.S., The Harenills, Leeds.
Lyon, Isidore Bernadotte, Great Medical College, Bombay.
Lyon, John George, Pontefract.
Lyte, F. Maxwell, F.C.S., Catford, Oakhill-road, Putney, S.W.
Macadam, Stevenson, Ph.D., F.R.S.E., F.C.S., Edinburgh
Macdougald, G. D., 41, Reform-street, Dundee
MacNamara, J. M., 6, Sudeley street, Kemp-town, Brighton
Mactear, James, F.C.S., St. Rollox, Glasgow
Makins, George Hogarth, F.C.S., Walton-on-Thames
Manning, F. A., F.C.S., 18, Billiter-street, E.C.
Marcet, W., M.D., F.R.S., F.C.S., Athenæum Club, Pall-mall, W.
Marreco, A. F., F.C.S., College of Physical Science, Newcastle-on-Tyne
Maskelyne, Nevil Story, F.R.S., F.C.S., 112, Gloucester-terrace, W.
Matthey, George, F.C.S., 78, Hatton-garden, E.C.
McLeod, Herbert, F.C.S., Cooper's-hill, Staines
Meldola, Raphael, F.C.S., 21, St. John-street, Bedford-row, W.C.
Miller, F. Bowyer, F.C.S., Royal Mint, Melbourne
Mills, E. J., D.Sc., F.R.S., F.C.S., Anderson's College, Glasgow
Mond, Ludwig, F.C.S., Winnington-hall, Northwich
Morfit, Campbell, Ph.D., F.C.S., 16, Harley-road, N.W.
Morgan, Thomas M., Victoria College, Jersey
Moss, John, F.C.S., 300, High Holborn, W.C.
Morrison, R. Milner, D.Sc., 13, Douglas-crescent, Edinburgh
Mucklow, John Davies, F.C.S., 34, Penn-road, N.
Muller, Hugo, Ph.D., F.R.S., F.C.S., 110, Bunhill-row, E.C.
Muspratt, E. K., F.C.S., Seaforth-hall, near Liverpool
Napier, J., F.C.S., Gipping-cottage, Bramford near Ipswich
Nelson, Edmund, F.C.S., Scientific Club, Savile-row, W.
Newlands, J. A. R., F.C.S., 18, Josephine-avenue, Brixton-rise, S.W.
Newlands, B. E. R., F.C.S., Clyde-wharf, Victoria-dock, E.
Newth, G. S., New College, Hampstead
Nicholson, E. Chambers, F.C.S., Carlton-house, Herne-hill
Nicholson, Edward, M.D., F.C.S., St. Thomas Mount, Madras
Nickels, Benjamin, F.C.S., Sudbury, Harrow
Odling, W., M.B., F.R.S., F.C.S., 15, Norham-gardens, Oxford
Odling, Walter, F.C.S., Burton-on-Trent
Ogilvie, Thomas Robertson, F.C.S., 13, Forsyth-street, Greenock
Ogston, G. H., F.C.S., 9, Delahay street, Westminster, S.W.
Ollerenshaw, Samuel, Sutton Alkali Works, St. Helens
O'Neill, Charles, F.C.S., 72, Denmark-road, Manchester
O'Sullivan, C., F.C.S., 140, High-street, Burton-on-Trent
Packer, George Smithers, F.C.S., Cambuslang, by Glasgow
Page, David, M.D., F.C.S., Netherfield, Kendal, Westmoreland
Page, F. J. M., B.Sc., F.C.S., Assoc.R.S.M., University College, W.C.
Parker, John Spear, 13, New Porter-street, Sheffield
Parkinson, Robert, Ph.D., Bradford
Patterson, T. Law, F.C.S., Belmont, Margaret-street, Greenock
Pattinson, John, F.C.S., 75, The Side, Newcastle-upon-Tyne
Paul, B. H., Ph.D., F.C.S., 1, Victoria Street, S.W.
Pearce, Walter, B.Sc., F.C.S., Assoc. R.S.M., Maidenhead
Pedler, Alexander, F.C.S., Presidency College, Calcutta
Perkin, W. H., F.R.S., F.C.S., The Chestnuts, Sudbury
Phillips, J. A., C.E., F.C.S., 18, Fopstone-road, Kensington, W.
Plowman, Sidney, Residences, St Thomas's Hospital, S.E.
Pochin, Henry Davies, F.C.S., Barn Elms, Barnes, S.W.
Prevost, E., Ph.D., F.C.S., Royal Agricultural College, Cirencester
Price, Astley P., Ph.D., F.C.S., 47, Lincoln's-inn-fields, W.C.
Price, David S., Ph.D., F.C.S., 26, Great George-treet, W.
Procter, W. Wilson, 33 and 35, Side, Newcastle-on-Tyne
Purdie, T., jun., B.Sc., F.C.S., Assoc. R.S.M., Universitäts Laboratorium, Würzburg
Ramsey, William, Ph.D., F.C.S., University College, Bristol
Reddrop, Joseph, F.C.S., London and North Western Railway, Crewe
Redwood, T., Ph.D., F.C.S., 17, Bloomsbury-square, W.C.
Redwood, T. Boverton, F.C.S., Fairlawn, North Finchley, Middlesex
Rennie, E. H., B.Sc., (Lond.) Seaforth-lodge, 38, Maida-vale, W.
Reynolds, J. Emerson, M.D., F.C.S., Trinity College, Dublin
Reynolds, W. J., M.A., F.C.S., Royal Military Asylum, Chelsea, S.W.
Rich, Sidney W., 34, Gloucester-road, Croydon
Richards, Edward, Assoc. R.S.M., Barrow-in-Furness
Riley, Edward, F.C.S., 14a, Finsbury-square, E.C.
Rimmington, George, 9, Bridge-street, Bradford
Roberts, T., 4, Alfred-road, Handsworth, near Birmingham
Robinson, John, F.C.S., Downside, Stoke Bishop, Bristol
Robinson, G. Carr, F.R.S.E., University Laboratory, Edinburgh.
Robson, Thomas S., 57, Side, Newcastle-on-Tyne
Rocholl, Heinrich, Middlesbrough-on-Tees
Rodwell, George Farrer, F.C.S., Marlborough College
Ronalds, E., Ph.D., F.R.S.E., Bonnington-house, Edinburgh
Roscoe, H. E., Ph.D., F.R.S., F.C.S., Owen's College, Manchester
Rosenthal, G., Ph.D., Wandsworth-bridge-wharf, Fulham, S.W.
Russell, W. J., Ph.D., F.R.S., St. Bartholomew's Hospital, E.C.
Ryan, Dennis, The School of Medicine, Liverpool
Salter, Martyn John, F.C.S., 112, Forest-road, Dalston, E.
Savery, T. J., 13, London-street, London-road, S.E.
Schunck, E., Ph.D., F.R.S., F.C.S., Kersall, near Manchester
Sell, William James, B.A., 12, Downing-terrace, Cambridge
Senier, A., M.D., F.C.S., 12, Brownswood-villas, Finsbury-park, N.
Shenstone, William Ashwell, F.C.S., Exeter School, Exeter
Shepherd, H. H. B., F.C.S., Charnock-road, Clapton, E.
Sheppard, Thomas Williams, M.D., Patna, Bengal
Siebold, Louis, F.C.S., Oxford Street, Manchester
Siemens, C. W., D.C.L., F.R.S., F.C.S., 12, Queen Anne's-gate, S.W.
Smee, A. Hutchinson, F.C.S., 7, Finsbury Circus, E.C.
Smith, Arthur Percy, F.C.S., Temple Observatory, Rugby.
Smith, R. Angus, Ph.D., F.R.S., F.C.S., 22, Devonshire-street, Manchester
Smith, Watson, F.C.S., Steven-street, Stretford, near Manchester
Snelus, George James, F.C.S., Assoc. R.S.M., Workington
Sonstadt, E., F.C.S., Duncombe-road, Hornsey-rise, N.
Spiller, John, F.C.S., 2, St. Mary's-road, Canonbury, N.
Spiller, William, F.C.S., Atlas Works, Hackney-wick, N.E.
Stead, John Edward, Middlesbrough
Stenhouse, J., LL.D., F.R.S., F.C.S., 17, Rodney-street, N.
Steuart, Daniel Rankin, Broxburn, Scotland
Stevenson, J. Cochran, M.P., F.C.S., Westoe, South Shields
Stevenson, Thomas, M.D., F.C.S., Laboratory, Guy's Hospital, S.E.
Stewart, A. Young, F.C.S., Apothecaries' Hall, Blackfriars, E.C.
Stock, William Frederick Keating, F.C.S., Darlington
Stoddart, William Walter, F.C.S., 1, Park-street, Bristol
Stoker, George Naylor, Laboratory, Somerset-house, W.C.
Sutton, Francis, F.C.S., Norwich

Swan, J. Wilson, F.C.S., Moseley-street, Newcastle-on-Tyne
Szczepanowski, Stanislas A. Prus., F.C.S., 6, Stafford-place, Buckingham-gate, S.W.
Tate, Alexander Norman, 7, 9, and 11, Hackin's Hey, Liverpool
Tate, Walter, Bridgewater Smelting Company, St. Helens
Tatlock, Robert R., F.C.S., 138, Bath-street, Glasgow
Taylor, J., F.C.S., Farmers' Club, Inns of Court Hotel, Holborn, E.C.
Taylor, R. L., F.C.S., 45, Glendale, Lower Broughton, Manchester
Thomas, Joseph William, F.C.S., Pen-y-lan, Cardiff
Thomson, John Millar, F.C.S., King's College, W.C.
Thomson, William, F.C.S., Royal Institution, Manchester
Thorp, W, B.Sc., F.C.S., 39, Sandringham-road, West Hackney, N.E.
Tichborne, Charles, R.C., M.R.I.A., F.C.S., 40, Mary-street, Dublin
Tidy, Charles Meymott, M.B., F.C.S., 3, Mandeville-place, Manchester-square, W.
Tilden, William Augustus, D.Sc., F.C.S., Clifton College, Bristol
Tomlinson, Charles, C.R.S., F.C.S., 3, Ridgmount-terrace, Highgate
Tookey, Charles, F.C.S., the Museum, Jermyn-street, W.
Tribe, Alfred, F.C.S., Dulwich College
Tucker, Alexander E., The Rhymney Iron Works, Rhymney, South Wales
Tuson, Richard V., F.C.S., Royal Veterinary College, N.W.
Tyrer, Thomas, F.C.S., Garden Wharf, Battersea, S.W.
Umney, Charles F.C.S., 50, Southwark-street, S.E.
Vacher, Arthur, F.C.S., 12, Fitzroy-street, W.
Versmann, Frederick, Ph.D., 15, Trinity-square, Great Tower-street, E.C.
Vicaji, K. R., 10, Churney-road, Bombay
Vincent, Charles W., F.R.S.E., F.C.S., Royal Institution, Albemarle-street, W.
Vinson, W. E., Gloucester Gas Light Company, Gloucester
Voelcker, A., Ph.D., F.R.S., 39, Argyle-road, Kensington, W.
Watens, William Henry, F.C.S., 74, Brecknock-road, N.
Walker, John Francis, M.A., F.C.S., Sidney Sussex College, Cambridge
Wallace, William, Ph.D., F.R.S.E., 138, Bath-street, Glasgow
Ward, G., F.C.S., Buckingham-terrace, Headingly, Leeds
Warington, Robert, F.C.S., Harpenden, Herts
Watt, Alexander, F.C.S., 24, Thackery-street, Liverpool
Watson, David, D.Sc., F.C.S., Assoc. R.S.M., Broughton Copper Works, Manchester
Watts, John, D.Sc., F.C.S, University Laboratory, Oxford
Way, John Thomas, F.C.S., 9, Russell-road, Kensington, W.
Weldon, Walter, F.C.S., Rode-hall, Burstow, Surrey
Wells, G. I. J., Lugsdale Chemical Works, Widnes
Whewell, George, F.C.S., Exchange-chambers, Blackburn
Whiffen, William George, Lombard-road, Battersea
Williams, John, F.C.S., 18, Cross-street, Hatton-garden, E.C.
Williams, M. Witney, F.C.S. 18, Kempsford-gardens, Brompton, S.W.
Williams, William John, F.C.S., 28 Cambrian-view, Chester
Williamson, Robert, F.C.S, Messrs. Burt, Bolton, and Heywood, Silvertown, E
Wilson, George Ferguson, F.R.S., F.C.S., Heather-bank, Weybridge
Wilson, James Henry, Oak Hall, East Ham, Essex
Wilson, William V., F.C.S., Jubilee street, Mile end, E.
Wisser, Percy James, F.C.S., Marsden-street, Manchester
Witton, James Cecil, B.Sc., 29, Queen-street, Lancaster
Wood, G. W., A.K.C., F.C.S., 10, Addington-road, Bow
Wood, Charles Henry, F.C.S., 46, Loraine-road, Holloway, N.
Woodcock, Reginald C., F.C.S., 23, Abingdon Street, Westminster.
Wright, C. R. Alder, D.Sc., F.C.S., St. Mary's Hospital, W.
Young, James, F.R.S., F.C.S., Kelly, near Greenock
Young, William Charles, F.C.S., Plaistow, Essex

ASSOCIATES.

Arnold, A. E., 7, Jeffreys-square, E.C.
Bascombe, Frederick, 180, New Bond-street, W.
Bayne, James, F.C.S., Royal Veterinary College, N.
Beckett, G. H., F.C.S., 33a, Mindleton road, Dalston, N.E.
Bendix, David, F.C.S., Prince Regent's Wharf, Victoria Docks, E.
Billing, H. S., Plymouth Chemical Works, Plymouth.
Carpenter, H. S., F.C.S., Beckington-house, Weighton-road, Anerley, S.E.
Clark, W. Inglis, B.Sc., Messrs. Duncan, Flockhart, and Co., Edinburgh
Copley, James, Gregory-street, Nottingham
Cowper, Richard, F.C.S., Assoc. R.S.M., 3, The Residences, South Kensington Museum, W.
Davey, G. W., 8, Hawthorn-terrace, Barking, Essex
Davidson, James, Junr., Summerville, near Dumfries
Dobbin, Leonard, Park-lodge, Old-park road, Belfast
Dyer, Bernard, F.C.S., 17, Great Tower-street, E.C.
Firby, Alfred, 2, Fallowfield-terrace, Leeds
Gahan, William Patrick, Roscrea, County Tipperary, Ireland
Gaskell, Francis, Newnham-lodge, Spring-grove, Isleworth
Gill, Edward J. G., 59, King Henry's-road, N.W.
Gibson, John, Ph.D., F.R.S.E., 29, Greenhill-gardens, Edinburgh
Graham, C. C., Silwood, Tulse Hill S.W.
Greenish, Henry George, 20, New-street, Dorset-square, N.W.
Haddock, Arthur, Royal Institution, Liverpool
Hallen, R., Assoc.R.S.M., 12, Route du Landi, St. Denis, Paris
Hollis, Percy Best, Borax and Alkali Works, Widnes
Holmes, Frederick George, 46, Hill-street, Peckham, S.E.
Hooker, Ayerst, Henham, Court-Lodge, Lessness-heath, S.E.
Hughes, Hugh, 81, Troughton-street, Edgehill, Liverpool
Hutchinson, T. J, Lower Croft Bleach Works, Elton, near Bury
Jago, William, F.C.S., School of Science and Art, Brighton
Jobson, Thomas junr., Stock bridge Works, near Sheffield
Jude, K. H., D.Sc., 37, Kempsford-gardens, South Kensington
Lapraik, William, F.C.S., 211, Southgate-road, N.
Legg, J. E., High-street, Berkhampstead
Macadam, W. Ivison, F.C.S., Surgeons'-hall, Edinburgh
MacIvor, R.W. Emerson, 29, Queen-street, Melbourne
McGowan, George A., 22, East Claremont-street, Edinburgh
Marsden, Robert Sydney, Tapton grove, Sheffield
Matthews, C. G., F.C.S., St. John's-lodge, Beckenham
Miller, John, 19, London-street, Glasgow
Naigamvala, K. D., Elphinstone College Laboratory, Bombay
Nelson, Cuthbert Gordon, Royal Veterinary College, N.W.
Paterson, George, 93, Canning Street, Liverpool
Paterson, W. G. Spence, 24, Pitt-street, Edinburgh
Patterson, George, 16, Carleton-road, Tufnell-park, N.
Pearson, Alfred Naylor, Victoria and Albert Museum, Bombay
Powell, Legh Sylvester, F.C.S., 56, St. James-square, W.
Sear, Frederick, 17, Rodney-street, Pentonville, N.
Senier, Harold, F.C.S., 223, Milkwood-road, Herne-hill, S.E.
Smetham, Alfred, F.C.S., 18, Brunswick-street, Liverpool
Smith, Henry Russell, 1, Aubert-park, Highbury-park, N.
Starling, John H., F.C.S., the Avenue, Erith
Thorne, Leonard Temple, Feilenbergsche Institut, Hifwyl, near Berne
Toms, F. Woodland, F.C.S., 7, Bushby-place, Camden-road, N.W.
Walker, Henry Herbert, 344, Glossop-road, Sheffield.
Williams, P. Caradoc, 6, Parliament-place, Liverpool

Members are requested to send notice of change of address, &c., to the Secretary, Mr. Charles E. Groves, Somerset-house-terrace, W.C.

SPECIALITIES.

MANGANESE Finest Crystallised, Lump, Ground, and Granulated of every quality, and PREPARED for *Chlorine, Glass, Steel, Ferro-Manganese, Pottery, Battery*, and EVERY PURPOSE.

BAUXITE (Hydrate of Alumina) Of high percentage of ALUMINA and almost free from Iron The CHEAPEST, BEST, and MOST PROFITABLE article from which to produce ALUM, ALUM CAKE, and SULPHATE OF ALUMINA, &c. [BRAND, "IRISH HILL BAUXITE."]

FLUOR-SPAR Of the Very Finest Quality for Acid, Soda, Glass, Flux, and all purposes.

BARYTES (Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

CRYOLITE, Magnesite, Felspar, Arsenic, Phosphates French Chalk, Strontia, Wolfram, Chrome, Terra Alba, Rotten Stone, China Clay, Umbers, Ochres, Antimony, Calamine, Emery Stone all Oxides, and all

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,

MINE PROPRIETOR,

Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.

OFFICES—26 CHAPEL STREET, LIVERPOOL.

DAHL & CO.,

BARMEN (RHENISH PRUSSIA),

MANUFACTURERS OF

ANILINE AND NAPHTHALINE COLOURS.

SPECIALITY—Ponceau Naphthol-Reds as a Substitute for Cochineal.

Sole Agency and Depôt in England,

THEODOR BANG,

BENSON'S BUILDINGS, BASINGHALL ST., LEEDS.

WILLIAM AND WILLIAM T. FIELD,

MANUFACTURERS of the Celebrated STAFFORDSHIRE BLUE BRICKS, specially adapted for Chemical Plant, *i.e.*, Acid Towers, &c. Also all other kinds of Best Staffordshire Blue Bricks, Pavings, Plynths, Splays, Copings, &c. &c. Prices and samples on Application.

TESTIMONIAL.

"We have used the Blue Staffordshire Brick for Sulphuric Acid Towers, &c., manufactured by Messrs. Field, for the last fifteen years, during which time they have given great satisfaction. We recommend them to the Chemical Trade, believing there is nothing better in the market."—(Signed) WILLIAM HUNT and SONS, Lea Brook Alkali Works, near Wednesbury, Staffordshire, February, 1878.

TOLL END BRICK-WORKS,
TIPTON, STAFFORDSHIRE.

GREENBANK ALKALI WORKS COMPANY (LIMITED), ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{2}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application. Orders for small quantities executed for Cash against Invoice.

THOMAS ADKINS & CO., SMETHWICK, NEAR BIRMINGHAM

MANUFACTURERS OF SPECIALLY PREPARED RED LEAD FOR FLINT-GLASS MAKING.

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

JESSE FISHER & SON,
Phœnix Chemical Works Ironbridge.

CHEMICAL & PHYSICAL APPARATUS, BOTTLES, PURE CHEMICALS,

REAGENTS, STANDARD SOLUTIONS,

And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

MOTTERSHEAD & CO.,

Exchange Street and 10, Half Moon Street, MANCHESTER.

CARBOY BASKETS, 10 Gallons Size, with wires in handles worked up from bottom. Price, 11d. each; if tarred, 1s. 1d. 12 gallons, 1s. 0½d.; tarred, 1s. 3d. Other sizes in proportion.—Delivered free 5 miles from H. Hall, Barking, Essex,

TOWNSON & MERCER,

89, Bishopsgate Street Within, LONDON.

Wholesale and Export Dealers and Manufacturers of

CHEMICAL & SCIENTIFIC APPARATUS
PURE CHEMICALS, &c.,

For Analysis and the general Laboratory Use of Manufacturers and Professors of Universities, Schools, Mines, &c.

Now ready,
TOWNSON & MERCER'S COMPLETE CATALOGUE Chemical and Scientific Instruments, Pure Chemicals &c. Demy 8vo. Illustrated with upwards of 800 Woodcuts. Price 2s. 6d. post free.

S. A. SADLER, CLEVELAND CHEMICAL WORKS, MIDDLESBROUGH

Newfall Tar Works, Carlton;
Ammonia Works, Stockton-on-Tees;
and Stamshaw Chemical Works, Portsmouth.

And also of the Furness Tar Products Co., Ulverston.

London Office:—85, GRACECHURCH STREET.

Manufacturer of Benzole, Toluole, Xylol, Solvent and Burning Naphthas, Carbolic Acid and Disinfecting Powder, Refined Anthracene, Naphthaline, Black Varnish, Refined Tar, Crude Liquid Ammonia, Coal-Tar, Pitch, Creosote, Grease Sulphate of Ammonia, Pyroligneous Acid, Acetate of Lime, Wood Naphtha, Charcoal, &c., &c.

S. A. S. is always a buyer of Coal-Tar Naphthas, Crude Anthracen and all Tar Products.

All communications to be addressed to the offices at Middlesbrough

ESTABLISHED 1798.

ROBERT DAGLISH & CO., ENGINEERS, BOILER AND BRIDGE MAKERS, MILLWRIGHTS, BRASS AND IRON FOUNDERS.

Manufacturers of every description of Condensing, or High-pressure Blowing, Pumping, Rolling, Winding, and Patent Steam-engines, of any required power, for Irrigating, Draining, Mining, Rolling Mills, or Water Works purposes, and Manufacturers of every description of Chemical, Colliery, Copper Ore, Gold Mining, Glass, and Rock-salt Machinery.

Black-ash Revolving Furnaces of the Most Approved Type.
Bessemer Steel-Rail Plant.
Compressing-Engines for Collieries, Iron Works, and Weldon's Patent Bleaching-Powder Process.
Caustic, Chlorate, Decomposing, Nitre, Nitro-Glycerine, Iodine Potash, Sulphur, Acid, and Oxalic Pans.
Gas Producers Patent for Heating and other Purposes.
Pyrites Burners for Irish, Norwegian, and Spanish Ores of Improved Construction.
Patent Rousing Machinery for Brewers.
Retorts, Acid, Gas, Iodine, Nitric, Nitre, Nitro-Glycerine, and Vitriol Refining.
Steam Superheaters improved for Oil, Tar, and Resin Refining.
Steam Sulphur Melter.
Stills for Oil, Resin, and Tar.
Wheels, Bevel, Mitre, and Spur Moulded on the Shortest Notice by Patent Machinery.
Makers of MacTear's Patent Carbonating Furnace, Jones and Walsh's Patent Sulphate of Soda Furnace, Parnell and Simpson's Patent Causticiser, and Kynaston's Patent Alum Plant.

Lists sent on Application.

Photographs, Plans, and other information supplied on receipt of Order.

ST. HELEN'S ENGINE, BOILER, AND BRIDGE WORKS AND FOUNDRY, LANCASHIRE.

CHEMICALS, DRYSALTERIES, AND SPECIALITIES.—The Advertiser is open to take a few more Agencies or act as Representative for the above.—Address, D. A. Sharp and Co., Exchange Square Glasgow,

THE CHEMICAL NEWS.

Vol. XLI. No. 1062.

ON THE
DENSITY OF BROMINE VAPOUR AT A YELLOW HEAT.

By V. MEYER and H. ZÜBLIN.

The density of bromine vapour at a yellow heat has been examined according to our air-expulsion process, both for the nascent halogen and for its free state. The experiments with nascent bromine were readily successful, but with the free halogen, its great volatility occasioned difficulty in its introduction into the apparatus, which, in spite of many attempts, have not been overcome.

For the experiments with nascent bromine chemically pure platinum bromide was used, and the experiments were conducted in the manner already described. The temperature was the highest which can be produced with the Perrot furnace, about 1570°. The densities found were 3·78, 3·64, the value calculated for $\frac{3}{2}Br_2$ being 3 64. The theoretical density for Br_2 is 5·52. Hence, under these conditions, bromine displays exactly the same phenomenon of dissociation as have been observed with chlorine and iodine; its vapour-density being reduced one-third at a yellow heat. For the experiments with free bromine the authors employed a preparation purified by being rectified over potassium bromide. The determination of its vapour-density, conducted in watery vapour by the air-expulsion process, gave 5·38 as against the calculated value for Br_2, 5·52.

On attempting to repeat the determination at a yellow heat a peculiar difficulty was encountered. The bromine was weighed in thin glass globules, which were closed before the blowpipe and then thrown into the ignited apparatus. The experiment failed each time, because the globule exploded on entering the apparatus with such speed that the bromine was projected out of the vessel. This evil could not be overcome even by the use of stronger globules, and the authors only succeeded in avoiding the loss of the bromine by inclosing it in short strong capillary tubes of very infusible glass. Even so the evaporation took an explosive form, and there was no certainty that a part of the contents was not flung into the colder neck of the apparatus. The numbers obtained agree very imperfectly—4 30, 4·44, 3·94, 3·99, 3·78, 4·20, 4·14, and lie between the value calculated for Br_2 (5·52) and that for $\frac{3}{2}Br_2$ (3·64). M. Crafts, who experimented upon free bromine (not nascent), arrived at a similar result. At the highest temperature of the Perrot furnace, he found the vapour-density of bromine 4·39 and 4·48.

The inconvenience above mentioned has made it hitherto impossible to determine the vapour-densities of very volatile bodies, such as free bromine, water, &c., at a yellow heat. It may be probably overcome by the use of much larger receptacles than stood at the disposal of the authors who will continue their experiments upon bromine with platinum bromide only. The results are still imperfect, as bromine has been hitherto examined at very high temperatures only.—*Berichte der Deutschen Chemischen Gesellschaft.*

Certain Chemical Constants.—J. L. Janovsky.—The author contends that the valence of an atom or molecule is its greatest possible capacity of saturation, when it of course becomes a constant. He seeks to prove electrochemically, that the equivalent is a constant.—*Chemisches Central-blatt.*

ON THE BEHAVIOUR OF IODINE AT ELEVATED TEMPERATURES.

By V. MEYER.

In the earlier memoir of V. and C. Meyer, on the decrease of the density of chlorine at elevated temperatures to two-thirds of its normal value, it was mentioned that the behaviour of iodine was analogous. The author reports on the experiments which lead to this conclusion. The iodine employed was prepared from the purest commercial iodine by sublimation over iodide. It was kept in a closed bottle over sulphuric acid. The author assured himself of its perfect purity by titration with the purest arsenious acid, repeatedly sublimed.

With this preparation determinations were carried out at different degrees of heat. In order to know approximately the temperatures they were ascertained calorimetrically, as in the former experiments. The experiments took place (A) in a glass vessel (253°), in the vapour of amyl benzoate. B, in a glass vessel in the lead-bath, about the melting-point of sulphur. C, D, E, F, in porcelain vessels in a Perrot furnace, the temperatures being respectively about 586°, 842°, 1027°, and 1567°.

The experiments gave a result similar to that obtained with chlorine. Up to about 600° the density of the iodine vapour agreed exactly with the formula I_2. At 800° a strong decrease was perceptible, and from 1027° to about 1567°—that is, through a range of more than 500°—it remained unchangeably and exactly equal to the value calculated for $\frac{3}{2}I_2$. Thus in experiment A the experimental values obtained were 8·89 and 8·83 as against the calculated value 8·78.

In B, 8·84 and 8·85.
In C, 8·73, 8·71, and 8·71.
In D, where the temperature was 842°, the experimental values fell to 6·68, 6·80, 6·80.
In E, at 1027°, the results were 5·75, 5·74, as against the value 5·83 calculated for $\frac{3}{2}I_2$; and
In F, at 1567°, the experimental values were 5·67, 5·60 5·71, 5·81.

These data give the following view of the behaviour of iodine at high temperatures:—

Temperature.	Vapour-Density Found.	Theory.
253°	8·89 .. 8·83	For I_2: 8·78
450	8·84 .. 8·85	
586	8·73; 8·71; 8·71	
842	6·68; 6 80; 6·80	
1027	5·75; 5·74	
1570	5·67; 5·60; 5·71; 5·81	For $\frac{3}{2}I_2$, 5·83

The density curve of iodine vapour differs from that of chlorine by undergoing its decrease of density much earlier than the latter. Whilst chlorine was only fully converted to $\frac{3}{2}Cl_2$ about 1200°, in iodine the results obtained at 1000° agree closely with the value calculated for $\frac{3}{2}I_2$, and preserve this agreement unaltered as far as the highest temperature hitherto found applicable.

The results just communicated deviate in some points from those arrived at by MM. Deville and Troost in their admirable researches on vapour densities. This applies especially to the observations made about 1000°. Whilst at this temperature the author obtained closely the figures calculated for $\frac{3}{2}I_2$, the result of a determination of the boiling-point of zinc made by MM. Deville and Troost with an iodine thermometer, and therefore assuming the unchanging density of iodine vapour, leads to the number 1040°, *i.e.*, almost exactly to the same result as they obtained by means of an air-thermometer. How this contradiction is to be explained the author is not yet able to say, but will return to it in a subsequent memoir. He felt, however, bound to use the greatest precautions against any error made in the experiments about 1000°. Half a year therefore, after the experiments mentioned above a further

determination was made at about the same temperature, with completely new apparatus, and with iodine freshly prepared and purified. The result agreed exactly with that formerly obtained, the experimental density found being 5·88. He also repeated the determination of the vapour-density of mercury as a check on the applicability of his process at such temperatures. The result was 6·98 as against 6·91 by calculation.

Determination of the Vapour-Density of Iodine in Platinum Vessels.—The previous experiments for determining the vapour-density of the halogens were made in vessels of porcelain, the fitness of which for the purpose had been ascertained by special experiments. It seemed, however, desirable, in order to obviate possible objections, to repeat the experiments in vessels of a quite different material. The author selected, therefore, the platinum apparatus and the process as modified accordingly, described *Berichte*, xii., p. 2204. It was not possible to operate with chlorine, as according to the observations of Troost, Hautefeuille, Seelheim, and the author, it attacks platinum at a yellow heat: but with iodine the experiment could be conducted without difficulty. The results arrived at were 5·71, 5·81 (calculation for $\frac{3}{2}I_2 = 5·83$), and agree completely with those obtained in porcelain vessels. In these experiments the iodine was weighed in a small platinum jug, and its vapour only came in contact with platinum and nitrogen, as it was not necessary to cover the bottom with sand.—*Berichte der Deutschen Chemischen Gesellschaft.*

THE ESTIMATION OF CARBON IN STEEL.

By JAMES W. WESTMORELAND,
Associate of the Royal School of Mines, London.

In the Chemical News, vol. xl., p. 225, M. Sergius Kern, in a short note, impugns the accuracy of the colour test for the estimation of combined carbon in steel, and at page 263 of the same volume Mr. W. D. Hermann, in a letter advocating the direct combustion process, states the general opinion of chemists that the colour test is not accurate.

The objections to the direct combustion process are—that the steel is required in a fine state of division, and the uncertainty as to the completeness of the reaction, while the time required by any combustion process would prevent its regular use in steel works, where it is not unusual to test from thirty to fifty samples daily.

Having used the colour test extensively for some years, I find that in most cases the results obtained by it agree well with those obtained by other processes,—that concordant results are obtained by analysts working independently on the same sample, and that discrepancies which arise are due more to errors or inexperience than to any defect in the method.

In order to compare the processes I was requested to examine by colour test a series of samples of steel in which the carbon had been estimated by combustion (between sixty and seventy samples were examined) the greater number of the experiments being made in the year 1876, with others at intervals up to the present time.

The following are examples of the results obtained in 1876:—

	Carbon Per Cent.		
	A.	B.	C.
1.	0·285	0·280	0·30
2.	0·349	0·340	0·36
3.	0·158	0·152	0·18
4.	0·565	0·532	0·48
5.	0·147	0·122	0 16

The results in column A were obtained by combustion, the steel being dissolved in a solution of chloride of copper, &c., the separated carbon being finally burnt with oxide of copper in a stream of oxygen gas: this process, although tedious, is very accurate. The results in column B were obtained by myself, using the colour test, in the Bowling laboratory. The results in column C were obtained by the colour test in the laboratory of a South Wales steel works.

The following experiments were made in May, 1878:—

	Carbon Per Cent.		
	Combustion.	Colour Test.	
6.	0·355	0·35	
7.	0·515	0·50	
8.	0·189	0·19	
9.	0·29	0·27	
10.	0·415 0·41	0·42	
11.	0·05	under 0·10	
12.	0·622	0·67	0·647

The combustions were made as before, and the colour estimations by myself, then engaged as chemist to the Rhymney Iron and Steel Company.

The sample No. 11 shows one of the defects of the colour test—that it cannot be used for estimating very low percentages of carbon in steel, and, on the other hand, its indications with high percentages are not very exact. For steel works' purposes, however, where estimations ranging from 0·10 to 1·00 per cent combined carbon are required in large numbers and quickly, it is invaluable, taking but little time, and giving results agreeing well with those obtained by other methods.

Bowling Iron and Steel Works,
February 28, 1880.

BORACIC ACID AS A PRESERVATIVE.

By H. ENDEMANN.

Boracic acid has, for the last ten years, held a place amongst our antiseptics, and has frequently been recommended for the preservation of meats and vegetable substances. The original discoverer, Gahn, sold in Europe two mixtures.

The one was a mixture of one part of boracic acid with one part of alum; the other, one part of boracic acid with two parts of alum. These were called respectively "aseptine" and "double aseptine."

Provisions in part preserved by boracic acid are generally within the time of from one to two months covered with a black crust, provided they are kept in the ordinary oak provision barrels. Alum prevents this.

This observation, long ago published, I found verified in my own investigations. It was, at first, my intention not to preserve without salt, but to limit the quantity of the salt to be used by the addition of certain antiseptics. In the following, without going into the details of the numerous experiments, I shall give the results of those which are directly of interest to the question discussed in this paper.

It was found that fresh beef, packed with 1 per cent of boracic acid and a salt pickle of 50 per cent, remained sweet and wholesome for several months, even if kept at an average temperature above 80° F. It was likewise found that previously salted beef could not be preserved by the addition of boracic acid. From this it was evident that the process of salting removed from the beef certain substances, in the absence of which preservation became impossible. These substances proved, on further investigation, to be the phosphates. It was, therefore, not the boracic acid which had been the cause of the preservation, but, rather, substances which are produced by the action of the boracic acid—the *acid* phosphates.

I could cite a long list of materials which cannot be preserved with boracic acid, owing to the want of phosphates. In all these cases, however, preservation would

be possible if, with the boracic acid, a phosphate were to be added: a somewhat roundabout way, which can be improved, as I shall explain further on.

During my investigations regarding the disinfecting properties of various substances I had found that it is very difficult to develop bacteria in a fluid containing acid phosphates, and also that many acids are powerful disinfectants, destroying the life of bacteria completely, even if present only in small quantities. One part of HCl in 64 parts of Cohn's fluid, well stocked with bacteria, destroyed these completely.

I was led, therefore, to make experiments in which boracic acid was replaced by equivalent quantities of other inorganic acids, and thus ascertained that exactly the same results could be reached as with the use of boracic acid.

The best results were reached by the use of phosphoric acid, and mixtures of phosphoric acid and hydrochloric acid.

Phosphoric acid, even in dilute solution, acts powerfully on fresh meat, covering it with a white layer of coagulated albumen, which, however, on standing gradually disappears. Mixtures, however, where the PO_5 is partly replaced by HCl, do not act in a like manner; and, even if some precipitation should take place, will soon allow the meat to recover its original appearance.

Meats thus treated keep exceedingly well, and at least fully as well as when preserved, under similar circumstances, with an equivalent quantity of boracic acid.

Less favourable results were obtained by the use of sulphuric, nitric, and acetic acids, which is easily explained by the instability of these acids.

The preservation by means of boracic acid cannot, therefore, be considered as involving a new principle; it is merely a variation of, but by no means an improvement on, the time-honoured vinegar pickling. The insipid taste of free boracic acid and the acid phosphates prevents its easy detection, and brings consumers to the belief that the meat is fresh.

This peculiarity is the only one recommending the use of boracic acid.

A French commission, appointed to investigate the influence of boracic acid on the human system, found that it could be taken for a considerable time without producing any injurious effects. Yet it is certainly neither a regular constituent of the body nor is it contained in our food, and it is, therefore, doubtful whether the results reached by the commission must be considered as conclusive, as, in the course of time, constitutional difficulties may supervene, if such preserved provisions are taken for a considerable period.—*Journal of the American Chemical Society.*

A METHOD FOR ESTIMATING BISMUTH VOLUMETRICALLY.

By M. KUHARA,
Fellow in Chemistry, Johns Hopkins University.

BISMUTH may be estimated gravimetrically as—

$$2BiAsO_4.H_2O$$

(dried at 100° to 120°), by precipitating its nitric acid solution with arsenic acid or sodic arseniate, collecting the precipitate on a weighed filter after washing it by decantation, and weighing the filter and precipitate together.* In carrying out this process of estimation, however, various difficulties are met with.

It occurred to me that by taking advantage of Bœdeker's method for the estimation of arsenic acid,† the gravimetric method above referred to might be converted into a volumetric. My hopes were completely realised, as the new method gives very accurate results.

* H. Salkowski, *Journ. Prakt. Chem.*, 104, 170. *Zeitschrift für Anal. Chem.*, 8, 205.

† "Fresenius Quant. Analysis," p. 256.

The method was based upon the precipitation of bismuth, as $BiAsO_4$, from its nitric acid solution, by adding a measured quantity of standard solution of disodic arseniate in slight excess, and upon the determination of the amount of residual arseniate by means of standard uranic nitrate. In carrying out the estimation, the nitric acid solution of bismuth under examination must be free from hydrochloric acid, as well as substances precipitable by arseniate. Before entering upon the process of actual analysis, the amount of bismuth in a solution to be examined was approximately ascertained by the same method as that employed in the actual analysis.

Now a convenient quantity of the solution under examination was taken, a slight excess of disodic arseniate solution whose exact strength had been previously ascertained by a known weight of bismuth, was added to the solution, which was then agitated well without heating, and the mixture was set aside for a time to complete the reaction. The mixture containing the precipitate was rendered slightly alkaline with ammonia and then slightly acid with acetic acid. Now uranium solution, the relative strength of which as compared with that of arseniate had been previously ascertained, was allowed to run in from a burette very slowly, the mixture having been constantly well agitated to complete the reaction. The end of the reaction was recognised in the ordinary manner by means of ferrocyanide of potassium. From the amount of uranium solution used the excess of arseniate can be calculated; and from the actual amount of arseniate found by subtracting the excess from the whole amount taken, the quantity of bismuth can be easily calculated.

The following results were obtained:—

For the standard solution of arseniate about 20·87 grs. of disodic arseniate were dissolved in 1 litre of water, and for the uranium solution about 35·6 grs. of uranic nitrate.

Relative strengths of arseniate and uranium solution:—

	C.c. of Arseniate taken.	C.c. of Uranium Solution used.
1.	10	10·0
2.	10	9·9
3.	10	10·1
4.	10	10·2
		Mean = 10·06

1 c.c. of arseniate = 1·005 c.c. of uranium solution.

Standardisation of arseniate in terms of bismuth:—

	Grms. of Bismuth taken.	C.c. of Arseniate taken.	C.c. of Uranium Solution used.
1.	0·10	13	6·0
2.	0·10	13	5·9
3.	0·10	13	5·7
4.	0·10	13	5·7
5.	0·10	13	5·7
			Mean = 5·8

1 c.c. of arseniate = 0·01369 gr. of bismuth.

The following results were obtained by using a known weight of bismuth:—

	C.c. of Bi. taken.	C.c. of Arseniate taken.	C.c. of Uran. Solution used.	C.c. of Arseniate used.	Bismuth found.
1. ..	0·125	12	3·3	8·7	0·119103
2. ..	0·125	12	3·2	8·8	0 120472
3. ..	0·125	12	3·3	8·7	0·119103
4. ..	0·125	12	3 3	8·7	0·119103
5. ..	0·125	12	3·1	8·9	0·121841
6. ..	0·125	12	3·0	9·0	0·123210
7. ..	0 125	12	2·9	9·1	0 124579
8. ..	0·125	12	2·9	9·1	0·124579
9. ..	0·125	12	2·9	9·1	0·124579
10. ..	0 125	12	3·0	8·7	0·119130

These results were not quite satisfactory, so other experiments were made.

Uranic nitrate solutions of different strengths were prepared, and that containing 43·2 grs. of crystallised uranic nitrate in 1 litre of water was found to give the best results. The strength of the arseniate solution remained the same.

Relative strength of sodic arseniate and uranic nitrate:—

	C.c. of Arseniate taken.	C.c. of Uranium Solution used.
1.	10	8·95
2.	10	8·90
3.	10	8·80
		Mean = 8 88

1 c.c. of uranic solution = 1·126 c.c. of arseniate.

Standardisation of arseniate in terms of bismuth by using uranic nitrate solutions of different strengths:—

	Grms. Bismuth taken.	C.c. of Arsen. taken.	C.c. of Uran. used.	C.c. of Arsen. used.
1. ..	0·1	13	4·95	7·427
2. ..	0·1	13	5·10	7·258
3. ..	0·1	13	5·15	7·201
				Mean = 7·295

1 c.c. of arseniate = 0·0137 gr. of bismuth.

The following results were obtained by using known weights of bismuth:—

	Grms. Bismuth taken.	C.c. of Arsen. taken.	C.c. of Uran. used.	Excess of Arsen. found.	C.c. of Arsen. used.	Bismuth found.	Difference. Gain or Loss.
1.	0·125	12	2·57	2·893	9·107	0·124766	+0·000240
2.	0·125	12	2·60	2·927	9·073	0·124300	+0·000700
3.	0·125	12	2·60	2·927	9·073	0·124300	+0·000700
4.	0·125	12	2·55	2·871	9·129	0·125067	−0·000067
5.	0·125	12	2·56	2 882	9 118	0·124916	+0·000084
6.	0·125	12	2·60	2·927	9·073	0·124300	+0·000700

—*American Chemical Journal.*

A NEW ANÆSTHETIC.

At a recent meeting of the Edinburgh Odonto-Chirurgical Society in Edinburgh, Mr. W. Bowman Macleve brought under the notice of the members a new combination anæsthetic, which he had been using for some time past in his private studies with very successful results. It consisted in combining the administration or the exhibition of ethylen-dichloride with nitrous oxide gas The manner of administration was simple. It consisted solely in placing a small piece of sponge, retained in position by a clip within the way-tube or supplementary bag of the nitrous oxide inhaler, leaving sufficient space on each side of the sponge for the free passage of the nitrous oxide into and out of the bag. Only a very small quantity of ethylen-dichloride was required, viz., about half a drachm. The time of inhalation to produce anæsthesia measured from 60 to 90 secs., and the time of complete anæsthesia—during which time the sensation was sure to be more profound and agreeable than when induced by nitrous oxide gas alone—was from 1½ to 2½ minutes, which embraced a period of time sufficient to enable most of the operations required in the dental surgery to be comfortably performed. He further mentioned that in all the cases in which he had used this anæsthesia, upwards of sixteen in number, there had been a complete absence of sickness, and only one case in which there might be said to have been the slightest approach to stertorous breathing. The pulse was slightly more accelerated than normal, but was full and strong, and there was that absence of lividity which renders administration of nitrous oxide so disagreeable, and in some cases repulsive, to the onlooker, the lips alone, on the removal of the face-piece, presenting in any case, and that only occasionally, the faintest appearance of lividity. It had also this decided benefit over the single administration, that it produced a relaxation of the muscles so contrary to the almost spasmodic rigidity induced by nitrous oxide.

The Society resolved to experiment with this anæsthetic.

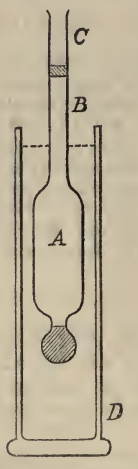
A NEW FORM OF INSTRUMENT FOR THE DETERMINATION OF SPECIFIC GRAVITY.

By F. P. DUNNINGTON.

The following easily portable apparatus, of which I have not seen any mention, affords a means of quickly obtaining the approximate specific gravity of bodies, and may be used under circumstances in which neither the balance, Nicholson's hydrometer, nor the spring balance of Prof. Jolly could be so conveniently employed.

This instrument consists of an hydrometer-shaped float, A, with the lower portion of the stem (B) graduated to one-tenth cubic centimetres, or other equal subdivisions of *volume*, and the upper portion (C) separated from it by a water-tight partition, the latter being left open above, and also graduated so that each subdivision shall mark off a volume contained in this tube C equal to the volume of the lower portion of the stem marked off by each of its divisions. Or by attaching the tube C to B, having the inner diameter of C equal to the outer diameter of B, portions of the same paper scale may be attached inside of B and outside of C, and the latter then covered with varnish.

This instrument may be most conveniently transported in the stout glass jar in which it is to float. It is used as



follows:—Partly fill the jar D with water of the temperature of the surrounding air; put a little water in C (enough to cover the substance of which the sp. gr. is to be taken), and read off its level; then float the instrument, and press it down—say five divisions—below the level at which it will rest, allow to come to rest, and take a reading of the depth at which it floats. Having broken from the substance, of which the sp. gr. is to be taken, a single lump which would nearly fill the upper tube, breathe on the piece, and with forceps carefully let it fall into the water contained in C (if a number of fragments or powder must be employed, after putting into the water in C, stir with a needle to get rid of air-bubbles); then, as before, press down the stem B the additional five divisions, allow to come to rest, and again read off the depth at which it floats, and the level of the water in C. The difference be-

ween the readings on B gives the volume of water equal to the weight of the substance added, and the difference between the readings on C gives the volume of the substance; then, dividing the former by the latter, we obtain the specific gravity.

The additional pressing down of the stem seems necessary to give uniformity to the meniscus formed on B. I find a little glycerin added to the water used in C serves well to perfect this meniscus: in making a reading of the level of the latter special care must be taken, since the appearance of the curves is altered when the substance comes near the surface of the liquid.

By using any liquid in the tube C, its sp. gr. may be determined with but 3 or 4 c.c., if it be not too volatile; and also the sp. gr. of solids soluble in water, but insoluble in some other liquid.

The instrument employed in making the following determinations has the following dimensions:—Cylinder (A), 50 m.m. long, 30 m.m. diam.; stem, 100 m.m. total length, 12 m.m. diam. The attached scale is of paper 60 divisions to the inch, the short tube C being attached by cement.

It would be preferable to have the tubes B and C united by fusion, and the scales etched upon the glass.

Uniform pieces of calcite, marble, and wolfram were selected, and the sp. gr. of each, for the temperature of the laboratory carefully taken, giving for these respectively

2·716	2 719	6·844

Of single pieces of each of these, weighing from 2 to 3 grms., the sp. gr. was thrice determined, giving—

(1)	2·72	2·77	6·58
(2)	2·77	2·83	6·85
(3)	2·72	2·78	6·95

Of single pieces weighing less than 1 grm. the sp. gr. was thrice determined, giving—

(1)	2·73	2·87	7·20
(2)	2·66	2·75	6·67
(3)	2·70	2 66	6·5

These eighteen determinations and their calculations required seventy-six minutes, and the longest time required for any one was five minutes.

It will be seen that there is considerable variation in these results, yet I would judge that they are sufficiently accurate for the ordinary use in determinative mineralogy.

University of Virginia.

AMMONIA FROM THE NITROGEN OF THE ATMOSPHERE AND THE HYDROGEN OF WATER.

On Wednesday, the 17th ult., was published a patent for the manufacture of ammonia from the nitrogen of the air and the hydrogen of water. The process is patented by Messrs. Rickman and Thompson.

Within the last twenty years the manufacture of ammonia synthetically has been several times attempted, and though in every attempt it is probable that ammonia has been made, yet never on a commercial scale. In all these attempts the process has been to combine the nitrogen and hydrogen directly at a low heat and receive the ammonia in solution in water, or by substitution, first forming a cyanide at a higher heat, and then indirectly producing ammonia by the decomposition of the cyanide, the result in both cases being ammonia in solution in water. Rickman and Thompson's procedure is altogether different; they produce ammonium chloride direct, and either in dry powder or in solution, and this by the simplest means and by the use of simple apparatus and inexpensive material. They do not use retorts, as has been done in all other cases, but simply a closed brick furnace having the ash pit closed to regulate the supply of air, and they cause the vapour of water to be produced by the waste heat of the furnace itself. The deoxidising material actually used is the dust of steam coal, which costs only 1s. 6d. a ton at the pits; to this is added from 5 to 8 per cent of common salt; and this coal dust is the only fuel used, except at the commencement, when a bushel or so of coke is used for lighting. The great difficulty in making ammonia from the nascent hydrogen of water and the nitrogen of the air is the restricted limits of temperature, between generation and decomposition; it being necessary that carbon, in whatever form used, should be at a full red heat to decompose the vapour of water; but at a bright red heat, ammonia is decomposed. Now ammonium chloride under the same conditions is simply volatilised and not decomposed. As chloride of sodium or of calcium is decomposed at a full red heat in presence of nascent ammonia, therefore one of these chlorides is mixed with the coal, that ammonium chloride may be formed; so that if by chance the heat should be raised to a bright red no loss is sustained; the ammonium chloride is simply volatilised. By these means a greater range of working temperature is obtained. At the present time, with the consumption of from 20 to 28 lbs. of the mixture of coal dust and salt per hour, from 2 to 3 lbs. of ammonium chloride is formed.

If the process be worked in the vicinity of the coal pits, which undoubtedly it will be, this coal dust and salt mixture will cost under 1d. This being so, the revolution in agriculture spoken of by M. Georges Ville in his Treatise on Chemical Manures, recently published here, cannot be far distant, if it is to be produced, as he predicts it will be, when ammonium sulphate is sold at 1d. per lb.

THE PURIFICATION OF GAS.*

By HARRY EDWARD JONES, M. Inst. C.E.

In dealing with the general subject, the author placed the purification of bisulphide of carbon in the foreground. The late Dr. Letheby, in 1860, was responsible for the introduction into an Act of Parliament of a limitation to 20 grains of this impurity per 100 cubic feet of gas. Until the year 1866, no such limitation had been put upon companies outside the Metropolis, and since then it had only been imposed in important towns. Such limitations were nowhere enforced or respected. Dr. Letheby had an opinion that it was only necessary to resort to the exclusive use of lime as a purifying material; nevertheless it was unsuccessful when adopted in the works of the late Ratcliffe Gas Company, an average for two years (1875-6) giving 28 grains per 100 cubic feet. In January, 1872, the gas referees reported the impossibility of fixing a limit. In 1877, the failure of the simple line process led to the adoption of a different plan; the carbonic acid was carefully eliminated. Success was, however, only occasionally attained, and the condition of the gas at the outlet of each purifier in the series was in consequence carefully tested and recorded day by day. These tests would have been a formidable business, but for the introduction at that time of Mr. A. Vernon-Harcourt's colour tests. It was found that though carbonic acid was never allowed to pass the first purifier of a set of three vessels worked consecutively, it was only possible to keep the sulphur low when the third purifier was receiving a considerable quantity of sulphuretted hydrogen. Further, that so soon as the first vessel was taken off for the necessary replenishing, the sulphur rose many grains, and did not fall until the replenished purifier had been put to work again as the third vessel, and its contents had received more sulphuretted hydrogen. This action was illustrated

* A paper read before the Institution of Civil Engineers, March 9th, 1880.

by a table and diagram, as was also the action of a series of four lime purifiers. The advantage of further carbonating the lime, on works which were closely surrounded by dwelling houses, led to the adoption of the Beckton system. As it became unmistakable that sulphuretted hydrogen was mischievous when in excess, arrangements were made for abstracting it as it left the carbonic acid system of purifiers, by interposing oxide of iron. This was carried out with marked improvement, and the effective life of the sulphide of lime was much prolonged. In practice, both for the relief of back pressure, and for facility in renewing a sulphide-of-lime purifier, the carbonic acid set of purifiers should yield the following results:—

	Crude Gas.	A	B	C	D	
Sulphur	40	52	45	30	28	Grains per 100 cubic ft.
Carbonic Acid	410	300	40	—	—	
Sulphuretted Hydrogen	800	900	400	—	—	

In this state of things the sulphur was generally 25 per cent. below that in the crude gas.

There was great advantage in exposing the material in the sulphide of lime purifiers to a current of air. Two purifiers at the Wapping works of the Commercial Gas Company, which had become ineffective, were opened, the lime examined, stirred up, and put back, and they afterwards worked for nine and eight months respectively, and did tenfold more work than previously. The prejudicial effect of cold in the reduction of sulphur in the carbonic acid system of purifiers, and the beneficial effect of the application of heat from the exhaust steam of an engine, were then referred to. No advance had been made in the direction of purifying in closed vessels with liquid agents. Mr. G. T. Livesey had succeeded in eliminating the carbonic acid to 0·5 per cent. in volume, by the use of rough caustic ammonia-liquor. The tar should be separated from the gas immediately on leaving the hydraulic main. The author allowed the gas to leave the condensers in summer at no higher temperature than that of the atmosphere, and, in winter, than 40° F.; in the former case the scrubbers usually reduced the gas to the temperature of 55°, and in the latter raised it to 45°. From the author's practice with water condensers he had found, in one type, that 1000 cubic feet per diem could be treated by 0·5 square foot of water. The result of condensation on the quality of the gas was then stated.

The purification of crude gas from ammonia proper was next referred to. The process was easy. The essentials were contact with extended superficies of water, or such concentrated intimacy as involved frictional resistance to the gas and the ultimate exposure of the gas to pure water. No sooner was lime substituted for oxide of iron in the scrubbers than ammonia appeared in the clean gas; this had been lessened by the addition of oxide of iron catch purifiers, and removed by a small quantity of sulphuric acid and sawdust in the last catch purifier. The cost of ammonia purification was very small, the particulars of which were stated.

Sulphuretted hydrogen was easily removed by lime, oxide of iron, peroxide of manganese, and sulphate of iron. Of these purifiers lime was the best, and oxide of iron the cheapest and least offensive. Oxide of iron, sulphate of iron, and manganese converted the sulphuretted hydrogen on exposure to the air into free sulphur, becoming oxides again, and being, as it was called, revivified.

Decomposition of Carbonic Acid by Plants under Artificial Illumination.—P. Dehérain and L. Maquenne.—Leaves plunged in water and exposed to a powerful light, such as that of a Drummond or a Bourbouze lamp, decompose carbonic acid and evolve oxygen. This phenomenon, however, occurs only so long as the luminous rays predominate. If the dark rays predominate, as when a Bourbouze light acts through a stratum of benzin or chloroform, oxygen is consumed and carbonic acid liberated.—*Ann. Agronom.*, v., 401.

PROCEEDINGS OF SOCIETIES.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

Report of Council.

As at the preceding annual general meeting, the Council has again to congratulate the members on the increasing prosperity of the Institute. At the time of the last meeting there were on the register 341 Fellows and 53 Associates, whilst at the present time there are 370 Fellows and 54 Associates, besides 1 Fellow who has recently been elected, but not yet formally admitted, making in all 425 members. Three candidates have been admitted to the Associateship of the Institute, and two who were Associates have passed to the grade of Fellow, so that there is only an increase of one in the number of Associates at present on the register. During the past year we have lost one Fellow by death, Mr. T. Wills, the Chemical Secretary to the Society of Arts, and two Fellows have resigned. The increase in the number of members must be looked upon as decidedly satisfactory, considering that the regulations under which candidates are admitted are now so much more stringent than in the preceding year; the thorough and searching examination in practical chemistry which is demanded of candidates for the Associateship has, for the present, limited the number who have taken the necessary step to qualify for that grade.

One of the two prizes of £50 offered by the President for original investigations involving gas analysis has been awarded to Mr. Leonard Dobbin, for his research on "Some Reactions of Tertiary Isobutylic Iodide," which has been accepted by the Council as sufficient and satisfactory evidence of training in practical chemistry to entitle him to the Associateship.

The numerous applications with reference to the qualifications necessary to obtain admission to the Institute are evidence that the advantages to be derived from organisation amongst professional chemists are more and more appreciated, and this is especially the case with the younger members of the profession. The small number of candidates who have hitherto presented themselves for practical examination would seem to indicate that the chemical student does not usually devote sufficient time to the attainment of a sound knowledge of analytical chemistry; there can be no doubt, however, that the thorough preliminary training required to pass the practical examination now imposed by the Institute as a condition of obtaining admission as Associate, will induce students to prolong the period of study, and to pay more attention to the various branches of exact analysis.

A meeting was held in February last immediately after the annual general meeting for the purpose of considering the alterations in the articles proposed by the Council, which alterations were carried unanimously. The members will recollect that the greater number of the changes introduced were for the purpose of avoiding the confusion arising from the manner in which the terms "Member" and "Fellow" were used in the original Articles of Association. As the articles stand at present, every chemist who has been formally admitted is a Member of the Institute, and is entitled to vote at all meetings, but Associates are not eligible as officers or Members of Council.

Conferences have been held since the last Annual General Meeting, at which the subjects discussed were:—

"The Adulteration of Food."

"The Relations of the Chemical Profession to Public Sanitation," that on the Adulteration of Food occupying two evenings. These meetings have been so successful hitherto that the Council has decided to continue them. It is a matter of regret that the great body of the members of the Institute in the provinces cannot attend these meetings, and thus have an opportunity of taking an active part in the discussions; but, in order to obviate

this difficulty as far as possible, it has been decided to print the paper which forms the subject of discussion and circulate it amongst the members some time previously, so as to afford those who reside away from London and cannot attend the meetings an opportunity of forwarding to the secretary any remarks they may desire to make, which can then be read at the meeting. It was also thought that this step would give members an opportunity of carefully considering the subject before the meeting, and thus facilitate the discussion.

A Parliamentary Committee has been appointed, whose business it is to watch over any Bills which may be brought forward in Parliament which may concern the chemical profession, and to call the attention of the Council to any which they deem likely to affect the interests of the members of the Institute. Negotiations with the Pharmaceutical Society are pending for the alteration of the clauses in the Pharmacy Act which restrict the use of the title of "Chemist" to those registered under that Act, in the event of any amendment of the Act being brought into Parliament.

One of the two prizes of £50 each, offered by our retiring President, Prof. Frankland, for "the best original investigation involving gas analysis," still remains to be awarded. Dr. C. Meymott Tidy has also offered a prize of £25 for the best original investigation on "Special Reactions of the Alkaloids and their Separation from Organic Mixtures." These prizes are open not only to Associates, but to all persons, except Fellows of the Institute, who shall before the 31st December next have qualified themselves for the Associateship in all respects short of passing the prescribed practical examination, and the Council has decided to accept successful competition for these prizes in place of such practical examination.

The Institute is again indebted to the President and Council of the Chemical Society for the use of their rooms during the past year.

President's Address.

Dr. Frankland said—You have heard the Report of your Council and the financial statement of our treasurer, and I think you will agree with me that they are both eminently satisfactory. We have, on the year, an increase of upwards of 30 Members, and our income has exceeded our expenditure by some £277. Three years have not yet elapsed since the draft scheme for this Institute was laid before the Organisation Committee, when a Sub-Committee was appointed to take all necessary steps for our incorporation, when the names of 48 chemists were added to those of the Committee, and when the first Officers and Council were elected. Many obstacles had still to be overcome before the incorporation of the Institute was accomplished seven months later; and at the first annual general meeting, two years ago, only 225 Fellows had joined the Institute. To-day we have an aggregate of 425 Members, consisting of 371 Fellows and 54 Associates, a number which the Chemical Society had not attained before its twenty-third anniversary.

The mere number of our Members, however, so far from being a subject for congratulation, might be one to be deplored if a strict investigation of the qualifications of candidates for admission had not been maintained. By lowering our standard we could, doubtless, have doubled our numbers, but this would have been to forego the essential object of the organisation—the guarantee that consulting and analytical chemists are duly qualified for the proper discharge of the duties they undertake. An inspection of our register will, I think, convince you that your Council has fairly effected a separation of the competent from the incompetent members of the chemical profession, and although there are some practising chemists of eminence whose names we should like to see enrolled in our list of Fellows, it is satisfactory to know that their number is very small. The period during which they can be admitted under the provisional regulations is now rapidly drawing to a close, for, after the 2nd of October next, no one can, by the Articles, enter our body, either as a Fellow or Associate, without first passing the prescribed examinations. It is, therefore, desirable that our Members should use their influence to bring in those few competent chemists who may, from one cause or another, be still unattached to the Institute, for it is evident that the existence of obviously competent professional chemists outside our organisation will be a source of confusion to the public, and will tend to lengthen the time before Membership of this Institute will be considered to be as essential to the practice of chemistry, as are the corresponding badges of competency in the professions of law and medicine.

In my own individual experience as a teacher of chemistry, I find manifested amongst students, and especially amongst the better class, a continually increasing interest in the Institute; and I know, at the present time, many students who are undergoing special training for the Associateship. But the objects and advantages of the Institute are not patent to everyone; there are no popular developments of our functions, we have no journal, we have not hitherto enjoyed much notice from the Press, and we do not even hold any public meetings. Indeed, it would be contrary to our principles to push ourselves into notice with the object of adding to our numbers; but it is, therefore, all the more necessary that our *professorial* members should bring the Institute under the notice of their students, encouraging them to prepare for admission to the Associateship; for, by so doing, they would not only be contributing to the elevation of chemistry as a profession, but also to the better education of chemical students in general; since the training prescribed by us in theoretical and analytical chemistry, physics, and mathematics, with incentives to original investigation, is precisely that which is necessary for all competent chemists, whether professional or professorial.

It should never be forgotten that the paramount function of our Institute is the *registration* of trained chemists competent to undertake the investigation of the various problems which arise in ever increasing numbers in connection with the applications of our science to the arts, public health, agriculture, and technical industry; and the *publication* of this register in such a manner as to bring it to the notice of Government departments, boards of health, public sanitary Authorities, Manufacturers, and others who require the aid of chemical experts. But there are other subsidiary functions incumbent upon us of no small importance; amongst these are watchfulness of such legislation as is likely to affect our body, and, secondly, the cultivation of professional ethics and good fellowship by the holding of conferences for the discussion of questions arising out of the practice of our profession. Since incorporation, our parliamentary functions have not had many demands made upon them, but the Conferences on "Trade Certificates," "The Adulteration of Food," and "The Relations of the Chemical Profession to Public Sanitation," have excited much interest amongst our Members, and the reports of the discussions have no doubt been very useful as means of interchange of opinions on the subjects treated of.

Valuable suggestions for the utilisation of the Institute in other directions have been made from time to time, and probably some of these will ultimately be acted upon; but, as they involve the expenditure of considerable sums of money, they should be undertaken with deliberation and caution, for it behoves us, at the the outset of our career, to practise strict economy. We may at any moment be involved in parliamentary or legal proceedings; these are, of course, very costly, and our power for good in connection with them will be very much in proportion to the amount of our investments and the balance at our bankers. Much of our ultimate success in winning due recognition for the Institute will depend upon our steady accumulation of capital, and I consider it, therefore, a very fortunate feature in our present position, that the current expenses are so moderate. Thanks to the

hospitality of the Chemical Society, we are rent free; most of the work is done without remuneration, and our chief outlay is incurred in the performance of that most important function, the printing, advertising, and distribution of our register.

Our present position may, therefore, be thus summarised. We have as many competent members as we could hope to extract out of the general mass of professional chemists, our finances are in a flourishing condition, our standards for admission are as high as the scientific training in our schools and universities will allow, the register of our Members is annually put into the hands of those who are in the habit of resorting to the aid of professional chemists, and there is every reason to hope that the influence and progress of the Institute will be no less satisfactory in the future.

CORRESPONDENCE.

"NEW" METHODS.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xli., p. 114, Dr. J. Grossmann *introduces* "A *New* Method for the Alkalimetric Determination of Sulphates," which has during the last few years been several times introduced as "new." It has been proposed in 1877 by P. Haubst (*Ibid.*, vol. xxxvi., p. 227), but before that gentleman, and, as far as I can find, originally, by M. F. Jean (*Comptes Rendus*, 83, p. 973, in abstract in Chemical News, vol. xxxiv., p. 272, 1876). It was also described by Jean and Pellet n *Bul. Soc. Chim.*, in abstract in *Chem. Soc. Journ.*, 1877, vol. ii., p. 353.

It would surely be a simple matter to look over the indices of a few volumes of the Chemical News, or of any other chemical journal, before describing and publishing methods as "new." Much time might thus be saved to reading chemists, and confusion avoided.

A curious point will be noticed by attentive readers on comparing the abstract of Jean's paper in the Chemical News with Haubst's "original" paper in the same journal.

Jean, 1876.	Haubst, 1877.
". . The solution . . . is mixed with a slight excess of baryta water and then with Seltz water . . . It is raised to a boil, and the whole is filtered. . . .	". . Add a slight excess of baryta water and then pass in a current of CO_2 gas, or mix with it water highly charged with this gas; let it boil for a few minutes, and filter.
"The mixed precipitate having been washed with boiling water until the washing waters no longer present an alkaline reaction, the filtrate is mixed with tincture of litmus, raised to a boil, and titrated with a standard solution of sulphuric acid.	"The precipitate is washed with boiling water till the washings are neutral to test-paper, and the filtrate, which contains now the alkalies as carbonates, is titrated with . . . centinormal sulphuric acid.
"The quantity of sulphuric acid necessary . . . . is exactly the same as what was combined with the alkalies, potassa, or soda. . ."	"The amount of acid consumed is exactly the same as that originally combined with potash or soda."

The similarity may be accidental, but if so is remarkable enough to deserve being put on record.—I am, &c.,

Otto Hehner.

54, Holborn Viaduct, London
March 15, 1880.

"NEW METALLIC COMPOUND."

To the Editor of the Chemical News.

Sir,—In the Chemical News (vol. xli., p. 87) you reported Dr. Cole's lecture on a "New Metallic Compound," and I have endeavoured to avail myself of it, in taking a reverse or "matrix" from plaster medallions, the result of which, though dissappointing to myself, may be of interest to some of your readers.

As the lecturer considered it immaterial what sulphide was used, I used the common black sulphide of antimony (Sb_2S_3) which I had by me, and the proportions which I found most fluid at the temperature mentioned in the lecture were four parts of sulphide and three parts of sulphur.

This mixture took a sharp impression from embossed paper without injuring it in the least; but with plaster ($CaSO_4$) it was quite different, the two surfaces adhered together entirely all over like a solid block; and after trying many expedients to separate them, I was obliged to break off the plaster piecemeal. The parts in contact with the "metallic compound" were quite brown, altered in texture, and impaired in firmness, and thus the medallion of Dante was quite spoiled; but the metallic matrix formed in the experiment was sharp and good except for numerous small air bubbles, caused probably by a slight formation of sulphurous acid. If it be suggested that the plaster should have been oiled, I need only say that sulphuretted oil would quite spoil the plaster.

If the sulphur in the "metallic compound" were in a state of chemical union or combustion, the effects described could not be attributed to its presence.

To ascertain this point I subjected a portion of the "new metal" to the action of bisulphide of carbon, and in a few minutes it dissolved out the whole of the sulphur quite unaltered, that is to say, if 4 grs. Sb_2S_3 are fused at 320° F. with 3 grs. sulphur, and the mass when cold is well washed with bisulphide of carbon, there will be left 4 grs. Sb_2S_3, and the solution on evaporation yields 3 grs. of crystallised sulphur.

Under these circumstances, we surely cannot regard it as anything more than a concrete or cement, in which the sulphur acts as a flux to promote fusion at a lower temperature.

And may I venture to suggest that this ready separation of sulphur from the mass by mere solvents impairs its utility for many purposes; there are volatile products in coal-gas, which have a strong solvent action on sulphur, and in their presence such caulking would soon become porous, to the great loss of the companies.

And in the laboratory it would be necessary to bear in mind, that all volatile products which dissolve or soften sulphur would render the use of this lute or cement quite inadmissible.—I am, &c.,

Alfred Payne, F.C.S.

Ettingshall, Wolverhampton.

BLOWPIPE ANALYSIS.

To the Editor of the Chemical News.

Sir,—In expressing the gratification I feel at honest praise from a writer who understands the subject so well as "Triton" (Chemical News, vol. xli., p. 133) obviously does, I would venture to say, with regard to the "ellychnine pyrochrome" to which he objects, that the long name—derived from the Greek for a candlewick—is the worst part of it, but I could not get a better one.

I showed this test for lime, &c., to some gentlemen of the Royal School of Mines, in Jermyn Street, about five years ago, by touching the wick of a candle from which a blue pyrocone was being produced—with the causticised fragment of one of the old fossil bones kept so carefully in the Museum there—when I well remember one of the gentlemen present exclaiming "This is equal to strontia!"

the "this" referring, of course, to the intense red colouration thus produced. I firmly believe this red colour to be due to *burning hydrogen*, suddenly freed through the decomposition of part of the blue hydrocarbonous "flame" by the caustic lime, for three reasons:—

(*a.*) Because if you direct this blue hydrocarbonous pyrocone upon clean shining aluminium plate there is no result; but if you insert a fragment of caustic lime carbon is soon deposited.

(*b.*) The same fragment of lime which has afforded this fine orange-red colouration at the *base* of the blowpipe pyrocone, if inserted at its *apex*, or in what is called "O.F.," gives chiefly the *yellow* which is ascribed to sodium, but which I firmly believe to be due to "chemical water."

(*c.*) The fumes of common salt, volatilised by this pyrocone in a room, give it after a time a red mantle, fainter, but of the same tint as that afforded by caustic lime, and we *know* that hydrochloric acid is produced by volatilising common salt in ordinarily moist atmosphere, and, also, that undecomposed hydrochloric acid burns with a yellow flame.

The vesiculation test for potash in presence of soda, also objected to by your correspondent, is not properly described in my work, "Pyrology;" but if a little pure silica is fused with the test, and not too much of that—as too much alkali, either potash or soda, spoils the reaction—added to the bead of boric acid which is vesiculated and breathed upon, I think every candid operator will find that the presence of potash enables the vesicle to cloud over, and that soda only prevents such clouding over, but the proportion of silica has yet to be determined.

Your correspondent will perhaps be glad to hear that the examination of boric acid beads in which various oxides and sublimates, &c., had been decomposed by high microscopic power has afforded the most surprising results, promising to throw light on the much-vexed question of the real constitution of metals, &c., and to make the chemistry of substances *in fusion*, so little studied hitherto, "the Chemistry of the future."—I am, &c.,

W. A. Ross.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 8, February 23, 1880.

Formation-heat of Persulphuric Acid.—M. Berthelot.—The formations of oxygenated water, of persulphuric acid, and of ozone, are endothermic, and form a graduated scale.

Ozone, O_2+O, absorbs	14·8 cals.
Persulphuric acid, $S_2O_6+O(=S_2O_7)$ ..	13·8 ,,
Oxygenated water, $HO+O(=HO_2)$ ..	10·8 ,,

These bodies are respectively transformable(?) All three contain active oxygen; that is to say, such as is ready to act upon oxidisable bodies with more facility than ordinary oxygen, because they contain an excess of energy derived from the thermic excesses pointed out here.

Decomposition of Oxygenated Water and the Derivatives of Barium Binoxide.—M. Berthelot.—The spontaneous decomposition of hydrated barium binoxide is explicable by the displacement of the second equivalent of oxygen by water, the compound being thus converted into hydrated baryta, with disengagement of heat.

Combination-heat of Chloral Hydrate.—A. Wurtz.—The author, having repeated his experiments with the apparatus figured and described, finds that his former conclusions are confirmed, *i.e.*, that the vapours of water and of anhydrous chloral may be mixed without giving rise to a sensible disengagement of heat, a fact which supports the opinion that the vapour of chloral hydrate is a mixture and not a definite compound. M. H. Sainte-Claire Deville pointed out that in such experiments the temperature in the central receptacle is very much influenced by the proportion between the volumes of the respective vapours.

Production and Crystallisation of an Anhydrous Silicate in Presence of the Vapour of Water at Common Pressures.—S. Meunier.—The author has obtained crystals of enstatite by bringing into contact at a suitable temperature, vapours of water, of magnesium, and of silicon chloride.

Comparison between the Tension Curves of Saturated Vapours.—P. de Mondesir.—Not susceptible of useful abstraction.

A New Electro-magnet.—M. Chambrier.—The author enlarges the surfaces of the extremity of the nucleus and of the oscillating armature. He causes the nucleus to penetrate into a cavity formed in the armature, or he permits its circumference to penetrate into a circular groove hollowed in the armature.

Use of Tempered Glass for the Construction of Condensers.—M. Ducretet.—Vessels of tempered glass, used as Leyden jars, can receive very strong charges of electricity without being perforated, and consequently give condensed sparks of a power much superior to those commonly obtained. Plates of tempered glass may be employed for the same purpose.

Preparation of Acetylen.—E. Jungfleisch.—This memoir requires the accompanying illustrations.

Determination of the Combustion-heats of Glycerin and Ethylenic Glycol.—W. Louguinine.—The quantity of heat disengaged in the transformation of glycerin is 392,455 cals. Ethylenic glycol yields 283,293 cals.

A Digestive Ferment Produced during Panification.—Scheurer Kestner.—During panification there is produced a peculiar ferment, having a strongly digestive action npon the flesh of animals, analogous to the digestion produced by the vegetable pepsin of the carnivorous plants.

No. 9, March 1, 1880.

This issue contains the account of the annual meeting of the Academy, with the presidential speech of M. Daubrée, and the awards of the various prizes given as rewards for scientific observations.

Chemisches Central-blatt. No. 4, 1880.

Artificial Alkaloids.—A. Ladenburg.—The author proves the identity of the artificial atropin prepared from tropin and tropic acid with the natural base. By treating the salts of tropin with hydrochloric acid, he has obtained a class of bases which he names tropeins. Amongst these may be mentioned salicyl-tropein, phthalyl-tropein, and oxytoluyl-tropein. Hyoscyamin and duboisin may possibly belong to this class of alkaloids.—*Berlin Monatsber.*, 1879, p. 779.

Ichaboe Guano.—B. C. Niederstadt.—The analysis of a cargo after treatment with sulphuric acid.—*Landw. Vers. Stat.*, xxiv., 269.

Liquid for Preserving Vegetable Preparations.—J. Nessler.—Alcohol at 20 per cent. with the addition of a little calcium sulphite.—*Landw. Vers. Stat.*, xxiv., 275.

Contributions to the Analysis of Wine and Must.—R. Ulbricht.—For the last three years the author has used the method of Parkes for determining the cuprous oxide separated out in performing Fehling's test.—*Landw. Vers. Stat.*, xxiv., p. 253.

Improvements in the Iodine Industry and in the Determination of Iodine.—B. Wetzig.—The simplest and most certain method for the determination of iodine is that of Fresenius.

No. 5, 1880.

Use of Aluminium in the Laboratory.—F. Stolba.—The author recommends this metal for evaporating-dishes, spatulæ, clamps, &c.— *Listz. Chem.*, iv., 34.

Signification of Calcium Oxalate in Plants.—B. J. van der Ploeg.—Lime in leaves increases with their age, but there is not a proportionate increase in oxalic acid, Some leaves, as those of the chestnut and the elm, are free from this acid, whilst in others, such as rhubarb, it is found in excess as compared with the lime. During the growth of plants, lime accumulates in the leaves and the rind, but not in the seeds, the roots, or the wood. Oxalic acid probably serves to keep the albuminoids in solution. —*Naturforsch.*, xiii., 17.

Action of Diastase and Pytalin.—M. Kjeldahl.—The author examines the influence of temperature, time, and concentration upon the diastatic process. The action of pytalin upon crude starch is very trifling, but it is much stronger upon starch-paste.

Manufacture of Opal and Alabaster Glass.—The following mixture is now in use :—Felspar, 20 to 78 per cent; blue lime, 17 to 60 per cent; and heavy spar, 5 to 40 per cent.—*Moniteur de la Céramique.*

Detection of Copper in Olive Oil.—O. Cailletet.—The author dissolves 0·1 grm. pyrogallic acid in 5 c.c. of ether, adds 10 c.c. of the oil and agitates. Copper, if present, is precipitated as a pyrogallate and the liquid takes a brown colour.

Examination of Alkaline Dicarbonates.—M. Lalieu. —1 grm. pure $NaHCO_3$, if treated with an excess of acid, gives off 0·524 grm. or 264 c.c. carbonic acid. The commercial salt, a mixture of the mono- and di-compound, gives, with an excess of acid, a quantity of acid, which is called V, and is divided into two unequal parts. Let one part, *a*, be unchangeable $= \frac{264}{2} = 132$ c.c., which are required to combine with the total soda so as to form a neutral carbonate. The other portion, *b*, or (V − 132) c.c., forms the second molecule of carbonic acid. If, *e.g.*, *b* = 9-10ths, 8-10ths, 7-10ths, &c., of *a*, then the salt under examination consists of 9-10ths, 8-10ths, &c., dicarbonate, the residue being neutral carbonate. It is therefore sufficient to divide *b* by *a*, in order to find the proportion of dicarbonate. A more precise method is to determine the residue left on ignition as well as the volume of gas evolved.—*Journ. de Pharm. d'Anvers.*

Preparation of Water free from Ammonia.—The pipe conveying the steam from the still is not connected directly with the condenser, but opens into the bottom of a large iron drum containing about 10 gallons, whilst the head of the drum is connected with the condenser in the ordinary manner. Part of the steam condenses in the drum falls to the bottom, and is kept continually boiling by the inrush of steam. If the water is drawn off here by a suitable arrangement it is found perfectly free from ammonia, which is met with in abundance in the water running from the condenser. In this manner a gallon of water, perfectly free from ammonia, may be obtained per hour.—*Arch. Pharm.*, xv., 458.

Separation of Quinine from Strychnine.—M. Dwars. —The mixed solution is supersaturated with ammonia and shaken up with chloroform. After the latter is evaporated the residue is dried at 110°, dissolved in warm water with the addition of sulphuric acid, neutralised with ammonia, and mixed with an excess of ammonium oxalate. After the lapse of twenty-four hours the quinine is collected as oxalate, and weighed.—*Arch. Pharm.*, xv., 463.

Bulletin de la Société Chimique de Paris,
No. 12, Dec. 25, 1879.

Fermentations Produced on Extracting the Saccharine Juice of Beet-root by Diffusion.—MM. A. Millot and Maquenne.—Hydrogen is given off in consequence of the butyric fermentation, but the acetic acid which is formed may also, at the temperature of the operation, react upon the sheet-iron of the apparatus and produce a further quantity of hydrogen. The destruction of sugar amounts to 1 per cent.

Transformation of Bromised Styrolen into Methyl-benzoyl.—C. Friedel and M. Balsohn.—The authors heated bromised styrolen, with an excess of water, to 180°, in sealed tubes, for twelve hours. The products were hydrobromic acid and an oily matter containing methyl-benzoyl.

Limited Oxidation of Ethyl-benzin.—C. Friedel and M. Balsohn.—The authors conclude that in the oxidation of aromatic hydrocarbons, at least of those in which a group CH_2 is attached to the benzenic nucleus, there is first formed an aceton, which is then split up in the known manner.

Synthesis of Ethyl-benzin by means of Ether and Benzin.—M Balsohn.—This synthesis is effected by heating together 1 part of ether, 2 parts zinc chloride, and 4 parts of benzin, in a sealed tube, for twelve hours, at the temperature of 180°.

Russian Chemical Society, Session Feb. 1/13, 1879. —MM. Beilstein and Jawein communicate an exact method for the determination of zinc, consisting in the electrolysis of the solution of the double cyanide of zinc and potassium.

MM. Beilstein and Kourbatoff find that the principal product of the oxidation of bromo-naphthalin is phthalic acid. There is likewise formed a resinous body containing bromine and bromo-naphthalic acid.

M. Schalfeieff has ascertained that the melissic acid of Brodie is not a homogeneous substance.

M. Potilitzine described researches on the reciprocal displacement of the elements. At 20° chlorine acts upon the bromides of sodium, potassium, and silver, but the decomposition is never complete. In the sulphide of silver the percentage of sulphur displaced by selenium is 68·80; in copper sulphide, 48·01; and in lead sulphide, 65·72.

No. 1, Jan. 5, 1880.

Direct Combination of Cyanogen with Hydrogen and the Metals.—M. Berthelot.—Already noticed.

On Epichlorhydrin.—M. Berthelot.—Already noticed

No. 2, Jan. 20, 1880.

Explosion of a Platinum Retort used for the Concentration of Sulphuric Acid.—F. Kuhlmann (fils.)—Already noticed.

Action of Acetic Anhydride upon Certain Aldehyd Phenols.—P. Barbier.—The author has obtained acetyl-paroxybenzoic and acetylised oxytoluic aldehyds, the latter compound both in a liquid and solid state.

On Iso-phthalo-phenon.—E. Ador.—The author establishes the symmetric constitution of this body.

No. 3, Feb. 5, 1880.

Researches on the Reversion of the Phosphates in the Superphosphates used in Agriculture.—A. Millot. —The new reversion discovered by means of ammonium citrate is due exclusively to the action of phosphoric acid and acid phosphate of lime upon ferric oxide, forming bicalcic phosphate. On a pasty mass containing iron oxide, iron phosphates with an excess of base are formed, even if the mass is strongly acid. These basic compounds are not soluble in ammonic citrate.

Composition of Slate.—E. J. Maumené.—Many varieties of slate contain a large proportion of calcium car-

bonate, and are in consequence readily attacked by atmospheric agents, acids, &c.

Determination of Urea by means of Alkaline Hypochlorites and Hypobromites.—A. Fauconnier.—The author has observed that the presence of saccharose does not increase the proportion of nitrogen given off by urea under the influence of sodium hypobromite, but that in presence of glucose the theoretical quantity is obtained.

Influence of Sugars on the Determination of Urea in Urine.—M. Jay.—The conclusions arrived at are that neither glucose nor cane-sugar should be employed in the determination of urea, the former being alone attacked by the hypobromite, and the second yielding a volume of gas which increases with the strength of the solution.

On Active Methyl-propyl-carbinol, and on Certain Fungi effecting Complete Combustion.—J. A. Le Bel.—The Fungi in question are *Penicillium glaucum* and *bicolor*.

The Positions α and β in Naphthalin.—F. Reverdin and Nölting.—Already noticed.

Chemiker Zeitung.
No. 4, 1880.

Influence of Manufacturing Refuse on Animal Life.—Dr. Auerbach.—The author mentions a chemical manufactory in England where large quantities of solution of sodium sulphate accumulated, and in order to recover the salt were allowed to evaporate spontaneously in large tanks about 30 yards square. During an entire summer he observed in these tanks numerous water-beetles, *Gyrinus natator*, which on the approach of danger hid themselves among the crystals of Glauber's salt, and did not appear in the least incommoded by the nature of the fluid they inhabited. One of these tanks having leaked into a ditch and thus contaminated a river at the distance of about two miles, thousands of dead fish were seen floating on the surface.

No. 5.

A New Method of Determining the Value of Zinc-powder.—V. Drewsen.—If zinc-powder is brought in contact with sulphuric acid and acid potassium dichromate, using of the latter more than twice the quantity theoretically needful, the nascent hydrogen reduces the chromic acid to chromic oxide. To 1 grm. zinc-powder is added 100 c.c. of a solution of pure potassium dichromate (40 grms. to 1 litre), and two quantities of dilute sulphuric acid, each of 10 c.c., are introduced successively, stirring well all the time. As soon as the zinc-powder is dissolved, with the exception of a small residue of insoluble matter which is almost invariably present, an excess of sulphuric acid is added, and 50 c.c. of a strong solution of iron sulphate (200 grms. to 1 litre), the action of which upon the solution of the dichromate has been determined previously. A slight excess of the same liquid is then cautiously added, titrating afterwards back with the solution of acid potassium dichromate until a drop of the liquid is no longer turned blue by potassium ferricyanide. The quantity of potassium dichromate used, if multiplied by 0·66113, gives the metallic zinc present in the sample of zinc powder. The results obtained agree well with those furnished by the method of Fresenius, *i. e.*, combustion of the hydrogen by means of copper oxide, and weighing the water formed. For pure zinc the process is not applicable.—*Zeitschrift Anal. Chemie.*

NOTES AND QUERIES.

Valuation of Soda-Ash.—Being a subscriber to the CHEMICAL NEWS of some twelve or fourteen years' standing, I beg to ask the following question:—Having a quantity of soda-ash containing 52 per cent of alkali, and another quantity of weak soda-ash only containing 2 per cent of alkali, will you kindly tell me by what calculation I may find the proportion of each to add to bring the whole to the uniform strength of 34 per cent?—K.

MEETINGS FOR THE WEEK.

MONDAY, 5th.—Medical, 8.30.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Arts, 8. Robert W. Edis, F.S.A., "The Decoration and Furniture of Town Houses."
TUESDAY, 6th.—Civil Engineers, 8.
—— Zoological, 8.30.
—— Pathological, 8.30.
—— Royal Institution, 3. Prof. Huxley, "Dogs and the Problem Connected with them."
—— Society of Arts, 8. Mr. C. Pfounds, "Art in Japan."
WEDNESDAY, 7th.—Society of Arts, 8. E. C. Robins, F.S.A., F.R.I.B.A., "Buildings for Secondary Educational Purposes."
THURSDAY, 8th.—Royal Institution, 3. Prof. Tyndall, "Light as a Mode of Motion."
—— Royal Society Club, 6.30.
—— Society of Arts, 8. F. J. Friswell, F.C.S., "Recent Improvement in Benzine Colours."
FRIDAY, 9th.—Royal Institution, 8. Prof. Huxley, "The Coming of Age of the Origin of Species," 9. Astronomical, 8.
—— Quekett, 8.
SATURDAY, 10th.—Physical, 3.
—— Royal Institution, 3. Mr. James Sully, "Art and Vision."

THE JOURNAL OF SCIENCE
for April (Price 1s. 6d.), includes—
Our Friends and how we Treat them.
Organic Synthesis and its Social Bearings.
Instinct and Mind. By S. Billing.
Modern Advances in Meteorology
The Rate of Animal Development. By J. W. Slater.
On Water and Air. By Prof. Tyndall, D.C.L., LL.D., F.R.S. (Lecture IV.) Illustrated.
Analyses of Books. Correspondence. Notes.
London: 3, Horse-Shoe Court, Ludgate Hill.

ROYAL INSTITUTION OF GREAT BRITAIN.
ALBEMARLE STREET, PICCADILLY, W.
LECTURE ARRANGEMENTS AFTER EASTER, 1880.
LECTURE HOUR, THREE O'CLOCK.
PROFESSOR HUXLEY, LL.D., F.R.S.—Two Lectures on Dogs, and the Problems connected with them; on Tuesdays, April 6, 13. Half-a-Guinea the Course.
ROBERT HENRY SCOTT, Esq., M.A., F.R.S., Secretary to the Council of the Meteorological Office.—Four Lectures on Wind and Weather; on Tuesdays, April 20, 27, and May 4, 11. Half-a-Guinea.
JOHN FISKE, Esq.—Three Lectures on American Political Ideas viewed from the standpoint of Universal History; on Tuesdays, May 18, 25, and June 1. Half-a-Guinea.
PROFESSOR TYNDALL, D.C.L., F.R.S.—Six Lectures on Light as a Mode of Motion; on Thursdays, April 8 to May 13. One Guinea.
T. W. RHYS DAVIDS, Esq.—Three Lectures on the Sacred Books of the Early Buddhists; on Thursdays, May 20, 27, and June 3. Half-a-Guinea.
JAMES SULLY, Esq.—Three Lectures on Art and Vision; on Saturdays, April 10, 17, 24. Half-a-Guinea.
PROFESSOR HENRY MORLEY.—Five Lectures on the Dramatists before Shakespeare, from the Origin of the English Drama to the Year of the Death of Marlowe (1593); on Saturdays, May 8 to June 5. Half-a-Guinea.
Subscription (to Non-Members) to all these Courses, Two Guineas.

INSTITUTE OF CHEMISTRY.
PRIZES.—DR. FRANKLAND has offered a Prize of £50 for the best Original Investigations involving GAS ANALYSIS; and Dr. C. MEYMOTT TIDY has also offered a Prize of £25 for the best Original Investigation on SPECIAL REACTIONS OF THE ALKALOIDS, AND THEIR SEPARATION FROM ORGANIC MIXTURES. These Prizes will be open to Associates, and to all persons (except Fellows of the Institute) who shall, before the 31st December next, have qualified for the Associateship in all respects short of passing the prescribed practical Examination, and successful competition for these Prizes will be accepted in lieu of such practical Examination. Further information may be obtained on application to the Secretary, Mr. C. E. GROVES, Somerset House Terrace, W.C.

Wanted, by a Chemist with a Practical Knowledge of the various Alkali Processes, an Engagement as Chemist or Sub-manager. No objection to go abroad. The highest references can be given.—Address F.C.S., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, a Practical Man to take charge of a Vitriol Rectifying Works. Liberal terms.—Address, C. 26, Henry Greenwood, Castle Street, Liverpool.

THE YORKSHIRE COLLEGE.

OPENING OF THE DYEING DEPARTMENT.
(Endowed by the Clothworkers' Company of London).

INSTRUCTOR—Mr. J. J. HUMMEL, F.C.S.,
Late of the Polytechnikum, Zurich, &c., &c.

The work of the Dyeing Department will begin in the new buildings, at College Road, Leeds (which have been erected for the Textile Industries and Dyeing Departments by the Clothworkers' Company), on April 13th, 1880. Lectures and Practical Work in the Dyehouse. Fees proportionate to the time students devote to the work. Prospectus may be had free on application to the Secretary, Cookridge Street, Leeds

Chemical Technology, or Chemistry in its

Applications to the Arts and Manufactures. By THOMAS RICHARDSON and HENRY WATTS. Second Edition, illustrated with numerous Wood Engravings.

Vol. I., Parts 1 and 2, price 36s., with more than 400 Illustrations.

Nature and Properties of Fuel: Secondary Products obtained from Fuel: Production of Light: Secondary Products of the Gas Manufacture.

Vol. I., Part 3, price 33s., with more than 300 Illustrations.

Sulphur and its Compounds: Acidimetry: Chlorine and its Bleaching Compounds: Soda, Potash: Alkalimetry: Grease.

Vol. I., Part 4, price 21s., 300 Illustrations.

Aluminium and Sodium: Stannates, Tungstates, Chromates, and Silicates of Potash and Soda: Phosphorus, Borax: Nitre: Gun-Powder: Gun Cotton.

Vol. I., Part 5, price 36s.

Prussiate of Potash: Oxalic, Tartaric, and Citric Acids, and Appendices containing the latest information, and Specifications relating to the materials described in Parts 3 and 4.

BAILLIERE and Co., 20, King William Street, Strand.

ORGANIC MATERIA MEDICA.

By DR. MUTER.

Analytical Chemists will find this a concise and yet complete book of reference for the isolation and examination of the active principles of drugs. Special appendix on the microscopic characters of the starches in food and drugs. Copious index and qualitative course or resins, &c.

Published by W. BAXTER at the Office of the South London School of Pharmacy, Kennington Cross, S.E., and sold by Messrs. Simpkin and Marshall and Messrs. Baillière, Tindal, and Cox.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44. Berners-street W.

THE SPRENGEL AIR-PUMP.

GIMINGHAM'S IMPROVED.

WITH MULTIPLE FALL-TUBES and every recent improvement, including McLeod's Gauge, Barometer Gauge, Radiometer, terminals for testing non-conductivity of the vacuum, &c., &c.

L. Casella having arranged with Mr. Gimingham for the sole manufacture of these pumps is prepared to supply them either in their simple form or with all or any of the accessories. Mr. Gimingham has engaged to examine each instrument, in order that no imperfect instrument may be sent away.

CROOKES'S RADIANT MATTER TUBES.—L. Casella has also the pleasure of stating that he is now able to supply the highly exhausted tubes illustrating Mr. Crookes's beautiful experiments on Radiant Matter, and guarantee their excellence, as each will be sent to Mr. Gimingham for examination before going out.

L. CASELLA, 147, HOLBORN BARS, LONDON, E.C.

FOR SALE.—Three Needham and Kite's

Patent Filter Presses, one 20 chambers, one 10 chambers, one 6 chambers.—For particulars and view apply to A. W. R. and N. Pott, at 22, Southwark Bridge Road, London, S.E.

SILICATE OF SODA, Solid and in Solutions

of Various Degrees of Concentration: the finest quality obtainable, and especially adapted for the use of Soap Makers and other Consumers.—JOSEPH CROSFIELD and SONS, Soap Makers, &c., Warrington.

London Agent—H. B. CLARKE 37, Great Tower Street, E.C.

SPECIALITIES.

MANGANESE Finest Crystallised, Lump, Ground, and Granulated of every quality, and PREPARED for *Chlorine, Glass, Steel, Ferro-Manganese Pottery, Battery*, and EVERY PURPOSE.

BAUXITE (Hydrate of Alumina) Of high percentage o Alumina and almost free from Iron The CHEAPEST, BEST, and MOST PROFITABLE article from which to produce ALUM, ALUM CAKE, and SULPHATE OF ALUMINA, &C.
[BRAND, "IRISH HILL BAUXITE."]

FLUOR-SPAR Of the Very Finest Quality for Acid, Soda, Glass Flux, and all purposes.

BARYTES (Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

CRYOLITE, Magnesite, Felspar, Arsenic, Phosphates French Chalk, Strontia, Wolfram, Chrome, Terra Alba, Rotten Stone, China Clay, Umbers Ochres, Antimony, Calamine, Emery Stone all Oxides, and all

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,

MINE PROPRIETOR,

Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.

OFFICES—26 CHAPEL STREET, LIVERPOOL.

DAHL & CO.,

BARMEN (RHENISH PRUSSIA),

MANUFACTURERS OF

ANILINE AND NAPHTHALINE COLOURS.

SPECIALITY—Ponceau Naphthol-Reds as a Substitute for Cochineal.

Sole Agency and Depôt in England,

THEODOR BANG,

BENSON'S BUILDINGS, BASINGHALL ST., LEEDS.

WILLIAM AND WILLIAM T. FIELD,

MANUFACTURERS of the Celebrated STAFFORDSHIRE BLUE BRICKS, specially adapted for Chemical Plant, *i.e.*, Acid Towers, &c. Also all other kinds of Best Staffordshire Blue Bricks, Pavings, Plynths, Splays, Copings, &c. &c. Prices and samples on Application.

TESTIMONIAL.

"We have used the Blue Staffordshire Brick for Sulphuric Acid Towers, &c., manufactured by Messrs. Field, for the last fifteen years, during which time they have given great satisfaction. We recommend them to the Chemical Trade, believing there is nothing better in the market."—(Signed) WILLIAM HUNT and SONS, Lea Brook Alkali Works, near Wednesbury, Staffordshire, February, 1878.

TOLL END BRICK-WORKS,
TIPTON, STAFFORDSHIRE.

JULIUS HÜLSEN & CO.,

NEWCASTLE-ON-TYNE,

AGENTS FOR THE BRAND (B.C.).

BLANC FIXE for Paper Enamelling Purposes; Dull and Bright Surface.

CHLORIDE OF BARIUM, Calcined, 95%, for Sugar Refining purposes, &c., &c.

MANUFACTURED AT THE

BLAYDON CHEMICAL WORKS,
BLAYDON-ON-TYNE.

Silicates of Soda and Potash in the state of

Soluble glass, or in CONCENTRATED SOLUTION of first quality, suited for the manufacture of Soap and other purposes supplied on best terms by W. GOSSAGE and Sons, Soap Works, Widnes, Lancashire.

London Agents, COSTE and Co., 19 and 20, Water Lane, Tower Street, E.C., who hold stock ready for delivery.

THE CHEMICAL NEWS.

Vol. XLI. No. 1063.

PEROXIDE OF HYDROGEN AND OZONE.

By ALBERT R. LEEDS, Ph.D.

In the Chemical News (vol. xxxviii., pp. 224, 235, 243, 249, and 257) I published a series of articles, the chief object of which was to prove that when the so-called atmospheric ozonoscopes were prepared with the utmost precautions, and subjected in the laboratory under known conditions to the operation of vapours and gases other than ozone, such as nitrous acid, hydrogen peroxide, &c. (bodies existant to a greater or less extent in the earth's atmosphere), they all underwent change. Hydrogen peroxide affected all the ozonoscopes, thallous hydrate excepted. The results obtained with this were entered as doubtful. In one series of trials, operating with a very dilute solution of peroxide, the thallium paper was yellowed: in a second series, the yellow stain was upon the edge only of the paper, the centre remaining white. These results were there explained by the supposition of the "thallium peroxide undergoing reduction in contact with hydrogen peroxide, water and oxygen being liberated." In other words, while the effects of hydrogen peroxide in changing the thallium ozonoscope were visible, yet, accepting as true the generally received statement of Schönbein concerning the mutual decomposition of hydrogen and thallium peroxides, I attributed the final slight result to the reduction of any thallium peroxide first formed. This explanation was very unsatisfactory to me at the time, inasmuch as it necessitated the supposition of an initial oxidation, followed by a reduction effected by the continued operation of one and the same reagent, and I was engaged in its further study, when the publication of the admirable paper by E. Schöne on this subject, definitely settled the question.* He there demonstrates the fallacy of Schönbein's statement, and shows that hydrogen peroxide can convert thallous into thallic oxide, not only when the peroxide exists in solution, but also when it is in the form of vapour.

It may be regarded as established, therefore, that *none* of the so-called ozonoscopes necessarily indicate the presence of *ozone* in the atmosphere.

While my paper, written with the object of demonstrating the proposition just enunciated, was in course of publication, Mr. C. T. Kingzett made the unwarranted charge (Chemical News, vol. xxxviii., p. 243) that I seemed "to have fallen into an error committed by many other observers, namely, that of estimating as ozone everything in the atmosphere capable of colouring so-called ozonoscopic papers." Moreover, he based this charge on a misquotation, for in the paragraph he quotes, I speak not of the ozonic reaction, but of the "so-called" ozonic reaction, an epithet which he borrows in his own article.

In a later communication (Chemical News, vol. xl., p. 96), Mr. Kingzett says, "There is no known process of slow oxidation which has been established to produce ozone." Couched as it is in such positive terms, this assertion contravenes the statements of those who have experimentally investigated the subject during the past forty years. It might, therefore, not unreasonably be anticipated that Mr. Kingzett should bring forward some new and crucial experiments of his own. He adduces none. At the same time he fails to recognise certain distinguishing properties of ozone and hydrogen peroxide, and apparently is not conversant with many phenomena exhibited in the oxidation of phosphorus in moist air.

* *Ann. der Chem.*, vol. cxcvi., p. 58.

Now, the property of ozone, most strikingly characteristic, is its smell. This smell, so far as long-continued familiarity with it enables me to judge, and whether the ozone is derived from the oxidation of phosphorus, or results from the action of the silent discharge on pure and dry oxygen, or accompanies the electrolysis of acidulated water (and the smell in the three cases is identical), is possessed by ozone only. It is not the odour of phosphorus, nor of chlorine, nor of the oxides of nitrogen, although it is sometimes compared with these very dissimilar bodies. Concerning the odour of hydrogen peroxide, there appears to be wide diversity of opinion. Most of the works on chemistry, to which I have referred, state that it is odourless; one authority mentions that its odour is peculiar; another, that it resembles chlorine. The solutions which I have prepared at different times myself, carbonic acid being employed to decompose the barium peroxide, have not evolved any odour that I was able to recognise or perceive. But when air is forced for a few minutes through a phosphorus ozonator, such as is described in Chemical News, vol. xl., p. 246, the atmosphere of a large lecture room becomes insupportable from the diffusion throughout it of an invisible gas (not a white smoke, like the so-called antozone), and there is everywhere present the penetrating and irritating smell of ozone.

In the next place, ozone is very slightly soluble, and water, through which hydrogen has been passed at or below the common temperature, may be made to indicate the existence of dissolved ozone by appropriate tests.* It is certainly not too much to assume, that when water, through which ozone has been passed, is evaporated to one-tenth of its original bulk, its dissolved ozone is expelled. But under these circumstances 30 c.c. of a solution which originally contained 2·7 m.grms. of hydrogen peroxide, when evaporated down to 3 c.c., yielded on titration a result equivalent to 2·4 m.grms. of the peroxide. The loss was due either to the decomposition of 0·3 m.grm. of hydrogen peroxide, or to the expulsion of 0·44 m.grm. of dissolved ozone. The former is by far the more probable supposition, and in either case the body principally contained in the water was hydrogen peroxide. This water was contained in the first wash-bottle used in washing the ozone, generated by the action of phosphorus partly immersed in *aqua purissima*, upon air which had been previously purified from all pre-existent nitrogen compounds (ammonia, nitrous and nitric acids), organic particles, &c.† No *nitrous* acid was present in the water, as was shown by examination with Griess's test (meta-diamido-benzol), but it contained 0·49 m.grm. of nitric acid, and 0·066 m.grm. of ammonia. This determination was made upon 481 litres of air, the amount of ozone formed being 0·924 grm. The percentage of hydrogen peroxide in the first bottle of wash-water, as compared with the total weight of the air ozonised, was 0·00038 per cent.

In another trial, in which 420 litres of air were drawn over and 0·805 m.grm. ozone produced, the amount of hydrogen peroxide contained in the wash-water was 2·01 m.grms., or 0·00037 per cent of the total weight of the air aspirated. It contained also 0·075 m.grm. ammonia and 0·88 m.grm. nitric acid, but of nitrous acid yielded not a trace to meta-diamido-benzol. In a third experiment, in which 396·4 m.grms. of ozone were produced, the wash-water contained 0·37 m.grm. of nitric acid, no nitrous acid, and 1·3 m.grm. of hydrogen peroxide, corresponding to 0·00039 per cent of the total weight of the air ozonised. One word as to the close agreement in the percentages of hydrogen peroxide found in the wash-water employed in the various trials. It was an agreement not anticipated at the outset, and became evident only when the actual amounts of hydrogen peroxide, found in the course of experiments continued during the course of more than three

* *Ber. der Deutsch. Chem. Gesell.*, xii., 1831.

† "Upon Ammonium Nitrite, and upon the By-products obtained in the Ozonation of Air by Moist Phosphorus," Chemical News, vol. xl., p. 70, by the Author.

months, at their conclusion came to be calculated up as percentages of the total weights of the air used. The same agreement was found to exist between the amounts of *nitric acid* present in the wash-water, when their percentages were calculated in like manner. In the first trial, 27 litres of air being aspirated, the nitric acid was 0·000318 per cent of the total weight of the air; in the second trial, 108 litres of air aspirated, it was 0·000318 per cent; in the fourth, 85 litres aspirated, it was 0·000303 per cent; in the sixth, 262 litres aspirated, 0·000328 per cent. In these four experiments, water was used in the jars of the ozonator. In the third trial, 45 litres of air being drawn over, the nitric acid present in the wash-water was 0·00054 per cent; in the fifth trial, 90 litres aspirated, it was 0·00054 per cent. In these two trials, the bichromate mixture was used in the jars.

In another place (CHEMICAL NEWS, vol. xxxix., p. 157), I have shown that the amount of ozone produced by the oxidation of phosphorus, under given circumstances, is constant for any particular temperature, and consequently the generation of ozone may be graphically represented by a curve, the production at 6° C. being *nil*, rising to a maximum at 24° to 25° C., and then rapidly diminishing as the temperature approaches 44°, the melting-point of the phosphorus. The results above given warrant, it appears to me, the formulation of another proposition :—

2. In the oxidation of phosphorus in moist air there is formed both *ozone and hydrogen peroxide*.* The amounts of the two bodies evolved, under given circumstances, bear a constant relation to one another and to the air passed over, the percentage of hydrogen peroxide being very small as compared with that of the ozone. In the experiments quoted above, the temperature being 18° to 21° C., the percentage of ozone, as referred to the weight of air aspirated, was 0·15 per cent; that of hydrogen peroxide was 0·00038 per cent, or but 1-400th part of the ozone.

The amount of phosphoric acid in the wash-water, in the experiment in which 420 litres of air were aspirated, was 0·252 grm.; of phosphorous acid, 0·013 grm. It was determined by trial that the presence of phosphorous acid in the solution did not affect the titration of hydrogen peroxide. In this connection, it is likewise important to formulate the three following propositions :—

3. No nitrous acid is present among the final products. The presence of hydrogen peroxide is in itself a sufficient reason.

4. Both ammonia and nitric acid are present in the final products, the amounts found standing in a constant ratio to the quantity of air aspirated. In one trial the results agreed with those corresponding to the formula of ammonium nitrate.

5. The generation of ammonium nitrate and hydrogen peroxide is as invariable a feature of the phenomena observed during the course of the oxidation as is the production of phosphoric and phosphorous acids. For this reason any explanation of the phenomena which neglected the contemporaneous generation of ammonium nitrate and hydrogen peroxide would be imperfect.

The results and the above conclusions were arrived at and published in the early part of last year. The explanation brought forward at that time, and which as yet I have seen no reason to modify, was as follows† :—"As to the reason of the formation of ozone itself under these circumstances, it may be conjectured along with Lamont‡ and others, that it is connected with the uneven quantivalencies of the elements taking part in the reaction, which may be represented by the equation—

$$P_4+O_{14}=P_2O_3+P_2O_5+2O_3.$$

If this hypothesis be true, then we should anticipate the development of ozone whenever oxidation of a perissad occurred at temperatures compatible with the stability of the ozone molecule. Even at the temperature of combustion of hydrogen, this is supposed by C. Than* to be the case. He explains in this manner the presence of the ozone, which he states he has detected in the combustion of hydrogenous substances generally, and its absence in the combustion of carbon."

"In entering into new combinations the oxygen molecules must undergo temporary resolution into their constituent atoms. These, while *en route* to take up new positions in other combinations, and animated by their atomic energy, or energy of the nascent state, may either oxidise the oxygen molecule, or the nitrogen molecule, or the molecule of water. In the first place, ozone would be produced; in the second, regarding water as the basic body and NNO as the nitryl, there might be formed, as Hunt as indicated,† ammonium nitrate; in the third, hydrogen peroxide."

Subsequent to the publication of these results, Prof. McLeod took up the subject, and arrived at the conclusion that‡ "the gas obtained during the slow oxidation of phosphorus, possesses the properties of ozone, and not those of hydroxyl, the only known peroxide of hydrogen." He likewise states that it is extremely improbable that ozone and hydrogen peroxide are both formed, as these substances destroy each other. The principal quantitative experiment mentioned was that of passing the gas, first through a tube heated to various temperatures, then into a weighed sulphuric acid tube, and finally into a solution of potassic iodide and starch acidified with sulphuric acid.

In connection with these experiments, it is to be noted in the first place, that Prof. McLeod regards the question in the light of an alternative, the presence of ozone excluding that of hydrogen peroxide, and *vice versâ*. This view, though supported by the statements of Schönbein,‖ that the two bodies mutually decompose one another, is much weakened by the recent elaborate experiments of Schöne,§ who shows that when strongly ozonised oxygen containing 5·2 volumes per cent of ozone, is agitated with an hydrogen peroxide solution, containing 0·4 per cent of the peroxide, or three to four times as much of the peroxide as is adequate to destroy all the ozone, it is only after the lapse of half an hour that as much as half of the ozone is destroyed.

Why, then, if hydrogen peroxide and ozone were both present, did not a gradual increase in weight in the sulphuric acid dryer, as the gas was heated at various temperatures up to 200°, indicate the progressive decomposition of the former? The failure to obtain such a serial progression is not explained. Neither is there any explanation of how an increase in weight in the cases where heat was applied is necessarily to indicate the presence of hydrogen peroxide, when an increase (and that a much larger one) took place when no heat was used. Moreover, ozone itself undergoes decomposition at a temperature of 200°. But at this temperature Prof. McLeod obtains by titration a result corresponding to 3·4 m.grms., which is relatively greater than the amount obtained when the ozone was not heated at all.

I shall be glad if Prof. McLeod will convict me of error if I am mistaken in stating that the decomposition of his potassium iodide solution under these circumstances was due not to ozone (remaining after the air had been heated to 200°), but to the presence of free acid. In the early part of my own studies upon the subject, I investigated as an essential question whether a current of ozonised air could be accurately titrated by an acid solution of potassium iodide, and determined that it could not.¶ Unless the presence of oxygen be rigorously excluded from the

* This statement is not new. Hydrogen peroxide was recognised by Schönbein among the by-products of the oxidation of phosphorus.
† *Journ. Amer. Chem. Soc.*, i., 156.
‡ CHEMICAL NEWS, vol. xxviii,

* *Journ. Chem. Soc.* [2], vol. ix., 483; *J. Prakt. Chem.*, [2], i., 415.
† "Chemical and Geological Essays," T. S. Hunt, Second edition, p. 472.
‡ CHEMICAL NEWS, vol. xl., p. 307.
‖ *Journ. für Prakt. Chem.*, vol. lxxvii., p. 130.
§ *Ann. der Chem.*, vol. cxcvi., p. 240.
¶ *Phil. Mag.*, April, 1879; *Jour. Amer. Chem. Soc.*, i., p. 18,

solution, excessively dilute acidified solutions of potassium iodide change even in the dark. In the light, the strength of the solution remaining the same, the change increases in the same ratio as the relative increase of the surface of exposure of the solution to the light's influence. But when oxygen is excluded, strong solutions containing excess of acid may be exposed to the *direct light of the sun for days* without undergoing decomposition. Hence, when a current of air is allowed to pass through an acidified solution of potassium iodide, it is placed under conditions most favourable to its decomposition, and the amounts of iodine liberated will depend, first, upon the relative amounts of acid and iodide present, and, second, upon the intensity of the light and the relative dimensions of the surface of exposure. I have been most careful *not* to acidify the potassium iodide solution during the course of the experiment, but at its close, and then, for the reasons above mentioned, to add only sufficient dilute acid to decompose the iodate which has been formed, and titrate at once.

In conclusion, I wish briefly to summarise the arguments above stated. The gaseous body given off in the course of the reaction between moist phosphorus and air, has a very powerful and peculiar odour, which is identical with that produced in the electrolysis of acidulated water. This is not the case with hydrogen peroxide. Ozone is very slightly soluble in water, and is readily expelled from the solution on heating. Hydrogen peroxide is miscible in all proportions with water, and solutions containing as much as 1 per cent H_2O_2 may be concentrated by evaporation on the water-bath, until a higher degree of concentration is reached, without great loss of peroxide. (See also Schöne, *Ann. der Chem.*, 196, p. 60, and Davis, Chemical News, vol. xxxix., p. 221.) Wash-water, through which air ozonised by phosphorus has been passed, after concentration yields a reaction due to hydrogen peroxide. The absence of nitrous acid in such wash-water can be readily demonstrated. No statement has been made as to the relative amounts of ozone and hydrogen peroxide *generated*, but only as to the relative amounts *evolved*. The latter amounts are those which remain after the highly dilute atmospheres of hydrogen peroxide and ozone have operated upon each other in the ozonising chamber. The absolute amounts depend upon the temperature, the period during which the ozone and hydrogen remain in contact with one another, the rate of flow of gas, &c., but under given circumstances the ratio of the hydrogen peroxide in the *evolved* gas to the ozone, is a definite quantity. In the experiments detailed, as determined upon the first portion of wash-water, it was approximately the 1-400th part.

It must be borne in mind that this number does not represent the total amount of hydrogen peroxide, but only that dissolved in the first wash-bottle. This is the larger amount, but some is likewise present in the second wash-bottle, still less in the third, and so on. A portion escapes solution in the water, even when a number of wash-bottles are used, and finally passes into the potassium iodide employed to titrate the ozone. During the whole of this interval, the hydrogen peroxide and ozone are slowly decomposing one another, the results obtained, on titrating with potassium iodide solution, depending on the point in the series where the titration is effected. When the current of ozonised air issues again from the potassium iodide solution, it is laden with a white cloud. This white cloud is the antozone of Schönbein and other authors. It is, in fact, hydrogen peroxide, held in a state of aqueous suspension, and *is the product of the action of the ozone upon the potassium iodide solution*. As such, it is to be discriminated from the white cloud, which is to be seen in the first two or three wash-bottles placed directly in connection with the ozonising chambers of the phosphorus ozonator. This latter white cloud is likewise suspended hydrogen peroxide, but its origin is to be sought for in the same series of changes as that resulting in the production of the ozone itself.

It follows from the above, that the numbers obtained as the results of titrating the stream of ozone and hydrogen peroxide with potassium iodide, do not represent ozone only. They represent also the relatively minute amounts of hydrogen peroxide, which, as I have shown in the paper published in the early part of the preceding year and previously alluded to, always accompany the ozone generated by the action of moist air upon phosphorus.

Finally, I desire to mention in explanation of certain statements made in the latter part of the article, that they are founded upon experiments as not yet published, and that I have only been induced to make this preliminary notice of them, in order to complete an argument against what have appeared to me to be erroneous views.

NOTES ON SOLUBILITY.*

By D. B. DOTT.

Before proceeding to the matters more particularly pertaining to this paper, it seems desirable to say a few words on the general subject of solution.

Dr. Watts, in his "Dictionary of Chemistry," defines solution as "the liquefaction of a solid or gaseous body by contact with a liquid, the solid or gas being diffused uniformly through the liquid and not separating when left at rest." In the same article we read—"The product formed by the union of liquids one with the other is usually called a *mixture* if the two liquids are capable of uniting in any proportions whatever, and a solution when each of the liquids is capable of taking up only a limited quantity of the other." The definition is certainly incomplete without taking the last quotation as a qualification, for a liquid manifestly dissolves in another liquid in the same manner as does a solid or a gas, showing that there is no preliminary or accompanying liquefaction. I cannot leave these quotations without condemning what has always appeared to me a somewhat meaningless distinction between *solubility* and *miscibility*. It is customary to say, for instance, that ether dissolves a small proportion of water, but that ether and alcohol are miscible in all proportions. Is the difference here anything more than one of degree? When it is said that two liquids are perfectly miscible, is it not just another way of saying that each is capable of dissolving its own volume of the other? Moreover, the term *miscibility* is occasionally applied to that intimate mixture of liquids which is sometimes observed—as, for example, chloroform with glycerin, where the two liquids mix thoroughly so as to simulate solution, but after some time slowly separate. Indeed, this appears the more appropriate use of the expression.

I have read with interest in the Chemical News (vol. xxxvii., p. 47) a paper by William Durham "On Suspension and Solution." After describing a number of experimedts founded on such facts as the precipitation by sulphuric acid of clay suspended in water, which phenomenon is explained by the greater attraction of water for sulphuric acid than for clay, he concludes as follows:—"There seems to be a regular gradation of chemical attraction from that exhibited by the suspension of clay in water up to that exhibited in the attraction of sulphuric acid for water, which we call chemical affinity. Chemical combination, solution, and suspension differ only in degree, and are manifestations of the same force." Although, doubtless, these conclusions would not generally be admitted, I believe they are fundamentally true. Just as we have a gradation from a perfect gas through intermediate stages to a liquid, and from a liquid through various degrees of viscosity to a solid, so we may say that there is a gradual increase of force from mere adhesion up to the most unmistakeable instance of chemical affinity. For the sake of convenience, however, there is no harm in distinguishing

* A condensed report of a paper read before the Edinburgh University Chemical Society, February 11, 1880.

two classes of material phenomena, the physical and the chemical, and there should be no hesitation in referring solution to the former. It is true there are one or two facts which give some support to the chemical view of solution; such as the precipitation by water of a resin dissolved in alcohol, as likewise the instance already referred to in Mr. Durham's experiments. From the same point of view the solution of a salt in water may be regarded as a combination of the salt with water to form a fluid hydrate, which then diffuses through the liquid. On the other hand, combination in definite and multiple proportion, and other characteristics of chemical action which it would be superfluous to recite, have no place in solution, so that we are compelled to place solution among the purely physical phenomena.

Perhaps the best definition of solution I have seen given is that by Dr. Isidor Walz (*Pharm. Journ.*, [3], vi., p. 8), who gives the following expression:—"Solution is the penetration of the molecules of one or more substances into the inter-molecular spaces of another substance, and the consequent formation of a homogeneous resultant." My only objection to this definition is that it includes among solutions alloys and hydrates, as well as mixtures of gases, while it is unusual and confusing to speak of solution except in reference to liquids. The definition I have devised, although no doubt open to objection, better expresses, I think, the nature of the process than the definitions sometimes given:—

Solution consists in the Molecular Mixing of Distinct Liquids.

1. The degree of solubility extends from zero to infinity, and depends upon the nature of the liquids and upon the temperature and pressure.
2. When a solution under given conditions is incapable of dissolving more of one of its constituents it is said to be saturated as regards that constituent.
3. In the case of solids and gases, solution is preceded or accompanied by liquefaction, which is brought about by contact of the liquid with the solid or gas, the resulting solution not being capable of liquefying a substance after it has attained its point of saturation for the same.

We come now to those instances of solubility which suggested to me the writing of this paper. So far as I am aware it is not generally known that many alkaloidal salts are much more soluble when in the amorphous anhydrous state than when in the crystalline hydrated form. The salts to which my attention has been more particularly directed are the meconate of morphia and the hydrochloride of beberia. The neutral meconate of morphia crystallises from water in prismatic needles, having, when air-dry, the composition represented by the formula—

$$(C_{17}H_{19}NO_3)_2.C_7H_4O_7.5H_2O,$$

and when dried in the water-bath the five molecules of water are eliminated. Beberia hydrochloride has the composition when crystallised indicated by—

$$C_{18}H_{21}NO_3.HCl.4H_2O.$$

In dry air three of these molecules are given off, but the last is not lost under a temperature of about 120° C. As regards the solubility of these salts I have had some difficulty in coming to an exact conclusion. Storer distinguishes the two recognised methods of determining solubilities as the "method by digestion" and the "method of cooling." In the former of these the solvent has added to it an excess of the substance whose solubility is to be determined, the temperature being kept as nearly constant as possible, and the solution is agitated from time to time. If at two of these intervals the proportion of dissolved substance is found to be the same the solution may be considered saturated, and the results taken as correct. In the "method of cooling" a saturated solution is prepared at a certain temperature, and the solution is then allowed to cool to the temperature at which it is desired to determine the solubility. After remaining a sufficient time at that temperature, the amount of dissolved substance is estimated in the usual way. The question arises, What is a sufficient time to allow the solution to stand at the temperature finally attained before making the determination? Gay-Lussac in his experiments found that two hours were enough, and I observe that more recently (*Chem. Soc. Journ.*, 1876) Victor Meyer recommends the same time. Storer, is of opinion that wherever practicable the "method by digestion" ought to be followed, and that the employment of the "method of cooling" is principally responsible for the striking discrepancies in nearly all accounts of this class of constants, the source of error being the tendency of many substances to an indeterminate supersaturation when cooled from a higher to a lower temperature. If a sufficient length of time were allowed the results obtained by both methods would probably ultimately agree, but no adequate allowance has been made for this tendency to "supersaturation." *Two hours* may be a sufficient interval for some solutions, but *three days* are not sufficient for others, as the following figures will show:—A saturated solution of morphia meconate was prepared by "method of cooling." After remaining for two or three hours at 10° 278·96 grs. H_2O contained 28·95 grs. of the crystallised salt, or 1 part is soluble in 9·6 parts H_2O. After three days, 178·63 grs. H_2O contained 5·94 grs. salt, or 1 part is soluble in 30·0 parts H_2O at 10°. Of the same solution after ten days ($t = 11°$) 108·57 grs. H_2O contained 3·13 grs. of the salt, or 1 part is soluble in 34·6 parts H_2O. Similarly with a solution of morphia neutral tartrate. On the first day the proportion dissolved was 1 in 5·0; on the second day, 1 in 6·2; on the fourth day, 1 in 11·0; the temperature varying slightly on these occasions, but not in such a way as to account for the divergence in the results. What I wish particularly to call attention to, however, is the great difference in the solubility of these salts when crystalline and hydrated and when amorphous and anhydrous, as I have no doubt the tendency to "supersaturation" depends on the same cause. The solubility of morphia meconate (5-hydrate) was determined by "method by digestion" ($t = 12°$). 54·93 grs. H_2O dissolved 2·098 grs. of the crystallised salt, or 1 part is soluble in 26·1 parts H_2O. 94·45 grs. H_2O dissolved 3·592 grs. of the salt, or 1 part is soluble in 26·2 parts H_2O. We may therefore take the solubility of di-morphia meconate penta-hydrate as 1 in 26 of water at 12°. Of the anhydrous salt, 100 grs. of H_2O dissolved 45 grs. at 11°, or 1 part is soluble in 2 2 parts water. This result must only be taken as giving the minimum solubility, as it is impossible to digest a solution with excess of the hydrate for any length of time without crystals of the 5-hydrate rapidly forming. I have not so carefully ascertained the solubility of beberia hydrochloride, but 1 part of the crystallised salt is soluble in about 30 parts of H_2O at 18°. On the other hand, the amorphous salt, whether dried in the water-bath or by exposure to the air (in which latter case it contains very nearly the proportion of water for the 4-hydrate), is soluble in water to almost any extent.

The question I have put to myself is this—What is the explanation of these salts being so much more soluble in the anhydrous amorphous state than when in the hydrated crystalline state, and what is the cause of their tendency to form "supersaturated" solutions? Perhaps the explanation which most readily suggests itself is that the anhydrate and hydrate being distinct compounds, the former is more soluble than the latter, and that when a hot solution of the hydrate is prepared the hydrate decomposes into the anhydrous salt and water, while again, on the solution cooling, the anhydrate slowly re-combines with water to form the less soluble hydrate. This theory, if it agreed with all the facts, would be quite satisfactory: but there is at least one phenomenon which tends to disprove it. I refer to the avidity with which moisture is absorbed by some of these amorphous salts, notably by morphia meconate. Portions of this salt, prepared by evaporating a solution to dryness on the water-bath, were placed under bell-glass with a beaker of water. Moisture was rapidly

absorbed, the substance becoming sensibly wet to appearance and to the touch. On weighing these portions at intervals of twelve hours the maximum gain observed was 29·6 per cent. The weight then decreases pretty rapidly until the absorbed water is =13·6, and then the salt gradually dries up to the 5-hydrate. The percentage 13·6 agrees pretty well with that required for a 6-hydrate, 14·02, 11·68 being the increase required for the known 5-hydrate. These results rather militate against the theory of such salts dissolving as anhydrates. One would naturally expect that when a salt has a great affinity for water it would combine with the water when thrown into it previous to dissolving. Another view which may be taken of the phenomena under discussion is the assumed existence in solution of different hydrates of varying degrees of solubility. As is well known, this is the explanation usually given of the formation of supersaturated solutions of sodic sulphate, &c. We can imagine that when the anhydrous salt is added to water it immediately combines to form its highest hydrate, but that the least soluble hydrate gradually separates according to the same law by which the least soluble salt separates in a case of double decomposition. This explanation is still open to objection. If the least soluble hydrate has a strong tendency to form out, why does it not do so at once? Now it is evident that the conclusive point to determine is whether the high degree of solubility adverted to is a function of the anhydrous state or of the amorphous state. It has often been noticed that alkaloids when recently precipitated and in the amorphous condition are more soluble than when after standing some time they have become crystalline. It is easy to prepare amorphous hydrates of morphia meconate and beberia hydrochloride, having apparently the same composition as the described crystalline hydrates, and their non-crystalline salts are extremely soluble. More decisive than any of these is the experiment next described. If morphia meconate 5-hydrate be dried in the water-bath it still retains its crystalline appearance, unlike the anhydrate prepared as formerly described. Let it now be digested with water, and it is found to be no more soluble than the ordinary crystallised salt.

It must often have been observed that the presence of small quantities of colouring matters and the like greatly interferes with the separation of organic salts and crystalline principles from their solutions. That is to say, that a hot solution of such a strength that on cooling it becomes filled with crystals, will cool down to the same temperature without yielding any crystals if only certain impurities are present, the substance slowly crystallising out after some time, and this with compounds which are not known to form hydrates. It is sometimes remarked of such instances that the substance is more soluble in a solvent containing colouring matters than in the pure menstruum: but this is misleading if not quite incorrect, seeing that the colouring matters are present after the crystals have appeared, just as they were at first. In some cases mere traces of such colouring matters almost prevent a salt crystallising.

Having given a considerable amount of attention to this class of phenomena, I have come to the conclusion that these are genuine instances of "supersaturation": that is to say, that these compounds are not rendered more soluble by the presence of colouring matters, in the same way as calcic sulphate is rendered more soluble in water by the addition of hydrochloric acid; but that the colouring matters in some manner interfere with the formation of crystals, and favour the condition of "supersaturation." This depends, I believe, on the capacity of dissolved substances for existing in two distinct states, what we might perhaps call the *potentially amorphous* and the *potentially crystalline*, corresponding to the amorphous and crystalline conditions of solid matter. Assuming the possibility of this, we can then readily believe that colloidal colouring matters, being themselves incapable of crystallising, will tend to retain other dissolved substances in the same state as themselves, and thus retard the formation of crystals.

This theory of a twofold liquid state may seem a very large conclusion from meagre premises, but I feel convinced that some such theory is requisite, and that other phenomena besides those referred to will be found to favour this view of the matter. If it be true, for instance, as has been stated, that if the same salt solutions prepared in different ways will dialyse with very varying degrees of rapidity, it would seem that the same salt can exist in two liquid states.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Anniversary Meeting, March 30, 1880.

Mr. Warren De la Rue, President, in the Chair.

The President, in his annual address, contrasted the condition of the Society during the past year with its position in 1869, when he also was President. The number of Fellows has increased from 522 to 1034; the income from £1122 to £2720; the number of papers read from 31 to 75. The *Journal* has also increased both in value and importance, especially in the addition of the abstracts, which form such a complete compendium of the progress of chemistry. As regards the library, £500 have been spent in purchasing new books, and a card catalogue is being prepared to increase the facility for finding books. The President then referred to the rapid progress of chemistry which he had specially noticed on returning to the chair: much of the aspect of chemical thought has changed. The elements once looked upon as most stable are now considered to be at any moment liable to be dissociated. Some months back spectroscopic evidence was brought forward which tended to show that the so-called elements were in reality compound bodies, and now V. Meyer has succeeded in dissociating chlorine, bromine, and iodine. As regards the spectrum itself, specific functions and properties can no longer be attributed to various parts of it; for Captain Abney has shown that every part acts actinically, and holds out a prospect of producing permanent photographs of the spectrum in its natural colours. The artificial production of the diamond is also said to have been effected, but Mr. Hannay's communication on this subject is so vague that it is impossible to pronounce any opinion upon it. The joint observations of Hannay and Hogarth on the solubility of solids in gases promise results of great interest. Remarkable observations have been made by Cailletet, Ansdell, &c., on the behaviour of various substances, mixtures, &c., under great pressure. The researches of Gladstone, Landolt, and others, on the refractive indices of carbon compounds, have been greatly extended by Brühl. The President then alluded briefly to the great diligence of organic chemists in the investigation of carbon compounds, and especially to the elucidation of the constitution of alkaloids and the carbohydrates. The synthesis of isatin and Baeyer's researches in the indigo group must, it would seem, result ere long in the discovery of a method for the artificial manufacture of indigo. Ladenburg has prepared atropine from tropine and tropic acid, and thus probably the first steps have been taken towards the synthesis of an alkaloid. Much light has been thrown on the constitution of the bases of the pyridin and picolin series, of the nicotin and cinchona alkaloids and of starch. Recent facts seem to show that our present symbolic system is inadequate to represent the constitution of carbon compounds. A new element, scandium, has been separated, corresponding to Mendelejeff's ekaboron, thus verifying his sagacity and the importance of the "Periodic Law." The President then referred to the objects and position of the Research Fund, and expressed a hope that all whose fortune allowed

would contribute largely to this fund, and thus promote the advancement of a science which may have contributed greatly to their own prosperity. He thanked the Drapers and the Goldsmiths' Companies for their donations to the fund. During the past year death has removed fourteen Fellows.

At the conclusion of the address,

Mr. F. A. Abel proposed a vote of thanks to the President for his interesting address and for the zeal with which he had performed the duties of President during the past year. It had been a special pleasure to see Mr. De la Rue again in the Chair. Some of the older members would recal with gratitude the great exertions which had been made by Mr. De la Rue on behalf of the Society at a critical period of its history, when he was appointed Treasurer, and the present prosperous condition of the Society was in a great measure due to his efforts at that time. He hoped that the example set for a second time by the President would prove an incentive to others to subscribe liberally to the Research Fund.

Dr. Gladstone, in seconding the vote of thanks, said that he had listened with great interest to the successful *resumé* of chemical progress given by the President. The experiment of re-electing a former President for twelve months had proved a great success, and he hoped it would form a precedent. The small attendance was an indication not only of the holiday season but also of the peaceful prosperity which now reigned in the Society.

The President, in reply to the vote of thanks, said that as an original member he had taken great interest in the Society, and had been very glad to take up the management of the finances. The prosperous career of the Society was, however, due more to its own innate life than to any efforts of his. He had returned to the chair with some sense of his own inefficiency, owing to the enormous changes which had recently taken place in chemistry. He thanked the Council, Officers, and the Fellows of the Society for the kind way in which they had supported him during his year of office.

The Secretary read the Third Report of the Research Fund Committee. Grants to the amount of £495 have been made during the year. The assets consist of £4000 stock, and a balance at the bankers of £152. A detailed list of the grants is given. A donation of £105 from the Drapers' Company and £100 from the President form important items in the income. The Committee point out the desirability of obtaining further additions to the fund, as without such contributions the income from investments would have been quite inadequate. Results of investigations have been published by Dr. Tilden, Prof. Thorp, Dr. Wright, Mr. F. D. Brown, Dr. Armstrong, Dr. Bedson, Messrs. Hartley and Huntington. Dr. Japp has forwarded a paper, which will be read at the next meeting. Preliminary reports have been received from Dr. Dupré, and Messrs. Bolas, Burghardt, Jago, Shenstone, and Williams.

The Secretary then read the Treasurer's Report. The expenses on account of the *Journal* amount to £1870; on account of the Library, £607; house expenses, £191; various other items, including £720 for purchase of stock and a balance of £929 at the bank, make up a total of £4684. On the other side are—Balance at the bank in March last, £1964; subscriptions, &c., £2151; sale of *Journals*, £295; dividends, £217. The assets consist of £6988 Stock; balance at the bank, £927; cash in hand, £2

Votes of thanks were then passed to the Treasurer, the Auditors, the Officers and Council, and the Editor, Sub-Editors, and Abstractors of the *Journal*.

A ballot was then held for the election of Officers and Council, Messrs. Grosjean and Kingzett being appointed scrutators. The following were elected:—

President—H. E. Roscoe.

Vice-Presidents—F. A. Abel, C.B., B. C. Brodie, Warren De la Rue, E. Frankland, J. H. Gladstone, A. W. Hofmann, W. Odling, Lyon Playfair, A. W. Williamson, J. Dewar, J. H. Gilbert, N. S. Maskelyne, V. Harcourt, R. Angus Smith, J. Young.

Secretaries—W. H. Perkin, H. E. Armstrong.

Foreign Secretary—Hugo Müller.

Treasurer—W. J. Russell.

Other Members of the Council—M. Carteighe, C. Graham, C. W. Heaton, H. McLeod, E. J. Mills, J. M. Thomson, W. C. Roberts, W. A. Tilden, W. Thorp, T. E. Thorpe, J. L. Thudichum, R. Warington.

A Special Meeting was then held, at which the bye-law relating to the number of members required to be present for the election of Fellows was altered, the number 32 being substituted (Bye-laws, page 12, line 4) for 40.

Thursday, April 1, 1880.

Prof. H. E. Roscoe, President, in the Chair.

After a few remarks from the President on taking the Chair for the first time, the following certificate was read for the first time:—J. Taylor.

The President then called upon Mr. Groves to read a paper on "*Betorcinol and some of its Derivatives*," by J. Stenhouse and C. E. Groves. Some thirty-two years ago, in the course of an examination of lichens, a quantity of crude usnic acid from *Usnea barbata* and *Cladonia rangifernia* was submitted to destructive distillation. In the distillate a crystalline substance was found, of the composition $C_8H_{10}O_2$, homologous with and closely resembling orcinol; it was therefore named β-orcin. It was somewhat hastily inferred that the usnic acid in the above lichens was the source of the β-orcin. Subsequent attempts to prepare β-orcin by distilling pure usnic acid, however, completely failed. A quantity of *Usnea barbata* was therefore obtained, and the crude usnic acid extracted and submitted to destructive distillation. On adding to the distillate solution of chloride of lime a crimson-red colouration proved at once the presence of the orcinol-yielding body. On purifying the usnic acid no trace of the orcinol was obtained after destructive distillation. The source of the β-orcin—or, as the authors now name it, betorcinol—was therefore not usnic acid. To prepare Betorcinol, $C_8H_{10}O_2$ or $C_6H_2Me_2(HO)_2$:—*Usnea barbata*, carefully freed from other lichens, is exhausted with milk of lime, the solution precipitated by hydrochloric acid, and the precipitate boiled with lime and water. The clear solution is neutralised with hydrochloric acid and evaporated, when the crude betorcinol crystallises out. It is purified by crystallisation from benzene and from water; melts at 163° C.; it is less soluble than orcinol; gives a bright crimson colour with hypochlorites, orcinol a purplish red; the ammoniacal solution is rapidly coloured on exposure to air, whilst the corresponding orcinol solution is but slowly changed. Tetra-chloro-betorcinol, dichloro-betorcinol, the corresponding bromine derivatives, and a mono-nitro compound were prepared and examined. The acid which yields the betorcinol was separated after some trouble from the usnic acid by taking advantage of its greater solubility in cold ether. It melts at 186°, and decomposes at a somewhat higher temperature, carbonic anhydride and betorcinol being formed. It has the formula $C_{19}H_{20}O_7$, having the same relation to betorcinol that evernic acid, $C_{17}H_{16}O_7$, has to orcinol. As, however, it cannot be at present definitely asserted that it is a dimethyl-evernic acid, the authors have provisionally named it *barbatic acid*. Hesse obtained an acid from an usnea growing on *Calisaya* bark, melting at 172°, which he termed usnetic acid. This is probably not identical with barbatic acid, but the authors suggest that it may be an ethereal salt of barbatic acid, as Hesse used alcohol in extracting and purifying his substance.

The President, after complimenting the authors on the completeness and clearness of their communication, called on the Secretary to read a paper. "*Note on Chemical Equilibrium*," by M. M. P. Muir. The object of this

paper is to describe a few measurements of the variatio n caused in chemical changes by modifications in the conditions of these changes, and to attempt to generalise some of the conditions of chemical equilibrium looking at the phenomena from a dynamical point of view. The influence of the manner of mixing on the changes which occur when potassium permanganate, oxalic and sulphuric acids, react in the presence of sulphate of manganese is illustrated by numerical results, showing that during the earlier part of the reaction the velocity of the chemical change is greater when permanganate is slowly added, and the liquids are not thoroughly mixed until after three minutes. The disturbing influence of a secondary change upon the primary is illustrated by a few numbers representing the relative velocities of the solution of ferric oxide by sulphuric acid, alone, in the presence of zinc, and when aided by the passage of an electric current. In the two latter cases the velocity of the change is considerably greater than in the former. The nascent hydrogen appears to decompose the product of the primary change—ferric sulphate—and to set free sulphuric acid in contact with ferric oxide, the latter being rapidly acted upon. Attention is drawn to the work of Prof. Willard Gibbs, wherein the conditions of equilibrium of a system of heterogeneous substances are deduced from a consideration of the great principles of the conservation and dissipation of energy, and a rough attempt is made to connect the so-called chemical induction with the commonly occurring phenomena of chemical action, and to trace analogies between chemical and electrostatic induction. The general conclusions arrived at are that chemical changes are always complex; that each change consists of at least two parts, a direct and a reverse change; that during the progress of either of these, secondary changes may be induced, which will in their turn modify the primary changes; that systems not in phases of absolute stability tend to undergo changes by contact with very minute quantities of matter in phases other than their own; that such systems will always tend to pass into that phase, the passage to which is attended with the maximum loss of Entropy; but that this tendency may to a certain extent he prevented by the action of impressed force.

Dr. Armstrong thought that it would have been desirable to make a series of observations and take the mean results. Apparently only single observations had been made, and the slight differences observed might to some extent be due to experimental errors.

The President commented on the difficult nature of such investigations, but agreed with Dr. Armstrong that it would have been better to have made a series of observations.

The Secretay then read a communication from Japan, entitled "*Preliminary note on the Action of the New Diastase, Eurotin, on Starch*," by R. W. Atkinson, Professor of Chemistry at Tôkiô. Korschett described in the *Transactions* of the German Asiatic Society, in some detail, the Japanese brewing process (*Dingler's Polyt. Journ.*, 230, 76), and mentioned the occurrence of a soluble ferment, which he named Eurotin, in the fermenting material employed, having the property of dissolving starch and converting it into sugar. A brief description of the process was given by the author in *Nature*, 1878. The fermenting body is termed Koji and is prepared as follows :—Washed rice is soaked in water till soft; it is then steamed for some hours until the starch has gelatinised. When lukewarm the mass is sprinkled with spores of the fungus, *Eurotium oryzea*. The grains are then well mixed and exposed in trays to a temperature of about 25° C. In three days the mass is cemented together by the silky filaments of the mycelium and forms the "koji," which is used instead of malt in the brewery process. When extracted with water, koji yields a solution, reducing the Fehling test. When digested with water for about ten minutes the solution gives about 12 to 14 per cent of glucose. Alcohol also dissolves out sugar, so that probably some sugar is present in the substance before treatment with water. Korschett has shown that the cold aqueous extract of koji has properties resembling those of malt, and when added to gelatinised starch renders it limpid and forms sugar; he also concluded that the temperature of 45° to 50° was the most favourable to this change. The author of the present paper has examined more minutely into the chemical reactions of the brewing processes of the Japanese, and has come to the conclusion that the starch breaks up in this process into glucose and dextrin instead of maltose and dextrin, as in our mashing operations. Korschett assumed that maltose was formed, but gives no estimations of sugar or polariscopic determinations. The author then describes the process and gives analyses of the mash on different days. A mixture of koji, steamed rice, and water is made in the cold. On the 5th to 7th days, the mash is warmed by introducing tubs filled with hot water. The prineipal points in the analyses are given in the table below.

It is to be noted that between the 14th and 17th days, two further additions of steamed rice and water were made; and, again, on the 18th day a fourth addition of steamed rice ferment and water took place. The mash was then pressed, and during the interval the small quantity of dextrin underwent fermentation, and the specific rotatory power of the filtered liquid became almost *nil*. The filtered liquid (Saké), which contains the water used to rinse out the fermenting tuns, contains 11·14 per cent alcohol; glycerin and resin, 1·99; fixed acid, 0·13; volatile acid, 0·02; water, 86·72. The fermentation is probably spontaneous. The size of the ferment cells is a little less than that of the beer yeast. The author endeavoured to obtain the sugar formed by solution in alcohol, but no crystallisable sugar separated. Experiments made by mixing cold extract of "koji" with gelatinised starch invariably gave a rotatory power lower than that calculated from the amount of dextrose and dextrin, assuming only these two substances to be present. The author leaves the detailed consideration of these reactions for a future communication. At present he is satisfied to have shown that the diastase of "koji," unlike that of malt, yields glucose and dextrin when it acts on gelatinised starch.

Dr. Armstrong said that the paper was very suggestive and interesting, but he was sorry that more details of the methods and especially of the polariscope used were not given. He must differ from the author, and did not think that he had proved that glucose was formed. The author seemed to think that the formation of dextrose and dextrin was due exclusively to the eurotin, an unorganised ferment resembling diastase, and to neglect the action of the organisms present, which are, as is well known, capable of converting starch into dextrose.

Mr. Groves called attention to the large amount of alcohol present, and suggested that it might be due to the particular organisms present.

The Secretary then read a "*Note on the Produtcs of Combustion of Coal-Gas*," by L. T. Wright. Some years ago the author was much struck by the powerful odour, suggestive of ozone, which he noticed when coal-gas was consumed in a Bunsen burner in an atmosphere charged with the nitrogen oxides evolved from fuming nitric acid.

Per cent.	1st day.	3rd.	5th.	7th.	10th.	14th.	17th.	19th.	24th.	28th.
Alcohol	—	—	—	5·2	8·61	9·20	5·80	9·44	12·41	13·23
Dextrose	—	7·35	12·25	5·4	0·99	0·50	2·06	1·16	0·27	0·0
Dextrin	—	5·12	5·69	7·0	2·81	2·57	3·89	2·74	0·47	0·41
Starch and cellulose	38·2	26·5	21·49	15·64	15·67	16·15	19·25	132·6	10·22	8·69
Rotatory power ..	—	124°	106°	135°	100·7°	116°	160°	132·3°	48·2°	36°
Sp. gr. of mash ..	—	1·15	1·18	1·08	1·05	1·04	1·03	1·02	0·99	0·98

During some experiments on the estimation of sulphur in gas the author passed the products of combustion of a Bunsen burner through solutions of iodine, and noticed that after the iodine solution had been bleached, and the current of gas stopped, free iodine appeared after some time in the solution. This reaction was attributed to nitrous acid, and was completely prevented by adding sodium bicarbonate to the iodine solution; the sulphur could then be determined by burning half a cubic foot of gas. In 1877 the author proved that nitrous acid was produced by the combustion of coal-gas in ordinary air, but that if the gas and the air were both freed from ammonia no nitrous acid was formed (*Chem. Soc. Journ.*, 1879, *Trans.* 42); the futility of the ordinary methods of washing gases was also proved. The author has never had the least difficulty in obtaining a blue reaction with paper moistened with iodide of potassium and starch, when coal-gas is burning in a Bunsen burner. Since reading Mr. Ridout's paper on the production of ozone, read before the Society a few weeks back, further experiments have been made, and the author concludes that ozone is not formed by the combustion of coal-gas, and that while ordinary gas burned in air usually gives the blue colour with starch and iodide of potassium, no such reaction is obtained when ammonia and its compounds have been completely removed previous to combustion.

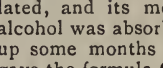
The SECRETARY then read a paper "*On Polysulphides of Sodium*," by H. CHAPMAN JONES. These bodies were usually prepared by the direct union of sodium and sulphur. The author establishes the existence of Na_2S_5, which on heating gives off sulphur, and leaves Na_2S_4, it being extremely difficult to obtain the substances pure. The body Na_2S_5 seems to be the highest sulphide procurable; in a body containing more sulphur than the penta-sulphide, the excess of sulphur seems to be merely dissolved. An aqueous solution of Na_2S_5, when gently warmed, evolves sulphuretted hydrogen; the penta-sulphide cannot therefore be satisfactorily prepared by boiling a lower sulphide with excess of sulphur: on boiling the above solution no sulphur is precipitated, $Na_2S_2O_3$ and SH_2 being formed. The author has examined the action of cadmium carbonate and other cadmium salts on the penta-sulphide, and concludes that the precipitate consists of cadmium sulphide and sulphur, the latter being removable by carbon disulphide. The penta-sulphide is believed by the author to be a tetra-thio-sulphate: he hopes to be able to prepare the di- and tri-thio-sulphates, and has obtained on several occasions a substance (giving a dark green solution having an absorption-band) which may be one of these bodies. In conclusion the author gives some properties of a black residue which is uniformly left when sulphur is burned, but has not examined the substance, as Dr. T. Cross (*Berl. Ber.*, 1879, 788) is already investigating the subject.

The next paper was read by the SECRETARY. "*On the Reflection from Copper, and on the Colorimetric Estimation of Copper by means of the Reflection Cuprimeter*," by T. BAYLEY. The author has shown that the light reflected from metallic copper contains all the elements of white light, but that the region of the spectrum to the red side of the D line is more intense than in the spectrum of the reflection from a white surface of equal illumination; the light transmitted by dilute solutions of cupric salts is deficient in those rays which the spectrum of reflection has in excess. It follows that if we look at a copper surface through a sufficient thickness of cupric sulphate solution, the metal appears silver-white, for the solution absorbs the excessive rays which make the copper red. Upon these facts the construction of the "reflection cuprimeter" is based. The direct light from the sky is reflected from a mirror of copper through two vertical tubes, closed at the bottom by plates of glass. The sheaves of light were concentrated by lenses on two layers of tissue-paper moistened with glycerin. The level of the liquid in the tubes can be adjusted by means of an aspirator. A standard solution of copper is made by dissolving 1 grm. of copper in nitric acid, adding excess of sulphurous acid, and diluting to a litre. It was found that a depth of 8·01 centimetres of this solution gave the silver-white tint to the copper reflector. Iron does not interfere if reduced to the ferrous state. The degree of accuracy is shown by analyses. The apparatus is made by Messrs. Jackson, 65, Barbican.

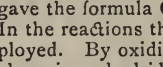
The next paper was "*On Pyrene*," by WATSON SMITH and G. W. DAVIES. The crude material was obtained from Dr. Schuchardt, and consisted of a dark brown crystalline mass. This was purified by solution in petroleum spirit and crystallisation. Crystals were light yellow; melted at 149°. A drawing of the crystals and a determination of the angles of the faces are given. The crystals are monoclinic. Analysis gave the formula $C_{16}H_{10}$. Vapour-density was found to be 6·912, calculated 6·999. The authors used Victor Meyer's method and a lead bath. They recommend smoking the glass, dipping into the melted lead in a luminous gas-flame: this prevents cracking and the adherence of the lead.

"*Analysis of the Ash of the Wood of Two Varieties of the Eucalyptus*," by WATSON SMITH. The two varieties were the red and blue gum trees, *E. rostrata* and *E. globulus*. The wood is remarkably hard, and gives rise to a powerful aromatic odour when planed. Specific gravity of *E. rostrata* is 0·8112, of *E. globulus* 0·752. Ash, respectively, 2·25 and 2·01 per cent; K_2O and Na_2O, 12·9 and 25 per cent; CaO, 43·8 per cent; 35·08 per cent, with small quantities of iron, alumina, &c. The author suggests the use of a decoction of the leaves of *E. globulus* as tea.

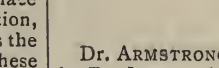
"*On the Action of Organo-zinc Compounds on Quinons (Second Notice)*," by F. R. JAPP. In a previous communication the author described a compound of the formula $C_{16}H_{14}O_2C_2H_6O$, but failed to isolate the substance $C_{16}H_{14}O_2$. In the present paper this body has been isolated, and its more important reactions studied. The alcohol was absorbed by sulphuric acid after being sealed up some months in an N-shaped glass tube. Analysis gave the formula $C_{16}H_{14}O_2$; the substance melted at 80°. In the reactions the compound $C_{16}H_{14}O_2C_2H_6O$ was employed. By oxidising a solution in glacial acetic acid with chromic anhydride a mass of orange-colour needles of phenanthren-quinon was obtained. By distillation with zinc-dust, and re-distilling the distillate, and treating the product with picric acid, the double compound of phenanthren and picric acid was obtained in long orange needles, melting at 145°, from which phenanthren was obtained, melting at 9·5° to 9·6°. On treating the compound $C_{16}H_{14}O_2C_2H_6O$ with caustic alkalies it dissolves, yielding a potassium salt in satiny flat needles, soluble in water. From the solution CO_2 precipitates the body $C_{16}H_{14}O_2$, which thus behaves like a phenol. The author then considers the question as to the constitution of the quinons, and comes to the conclusion, from the action of zinc-ethyl and from other considerations, that Graebe's views are correct, and that phenanthren-quinon has the structure of a peroxide, thus—



and is not, as suggested by Fittig,—



Dr. ARMSTRONG objected to the conclusions arrived at by Dr. JAPP, and thought that, though his argument was very ingenious, it was not conclusive; in fact, that it was just as likely that a substance having the constitution assigned by Fittig would give—



In fact, the probabilities were in favour of the first supposition when the behaviour of phenanthren-quinon with nascent hydrogen was considered.

The Society then adjourned to April 15, when the following papers will be read:—"On the Lecture Illustration of Chemical Curves," by Dr. Mills; and "On the Analysis of Organic Bodies containing Nitrogen," by W. H. Perkin.

NOTICES OF BOOKS.

Saint Germain-en-Laye. The Sewage of Paris. Operations of the Committee of Defence against the Projects of Stripping and Irrigating the Forest of Germain. (Eaux d'Egout de Paris. Travaux du Comité de Défense contre les Projets de Déboisement et d'Irrigation de la Forêt de Saint Germain-en-Laye.) Saint Germain: Bardin. Paris: Dunod.

The value of forests in a sanitary, climatic, and even agricultural point of view, is a question on which the educated public can no longer plead ignorance. Were no other evidence available, the document in which Baron von Müller, the Government Botanist of Victoria, pleads for the maintenance of the Australian woodlands ought to be more than sufficient. It is, therefore, with lively regret that we learn the revival of a project which threatens the destruction of one of the forests surrounding Paris. Saint Germain is to be sacrificed to one of the most obtrusive and persistent whims of modern times, and 1400 hectares (equal in round number to 3360 acres) of its pleasant and salubrious woodlands are to be converted into a—sewage irrigation farm! Against this unhappy project the eighteen adjoining communes have felt themselves bound to protest, and have formed a joint committee of defence. The labours of this committee have brought to light facts which ought not to be overlooked by sanitary reformers in England.

The very project of carrying the sewage on to St. Germain is an avowal that the vaunted irrigation farm of Gennevilliers is a failure. We were told, not very long ago, that the plain of Gennevilliers—the soil of which is of an exceedingly suitable nature—would be quite sufficient to absorb the whole of the sewage of Paris—to purify it, and to thus restore the Seine to its pristine limpid condition. Three hundred thousand cubic metres of fœtid water were thus to be treated day by day the whole year round. In actual fact, from 25,000 to 30,000 cubic metres — or say one-tenth part of the quantity desired—have been thus applied, and have been found excessive and injurious. What, then, becomes of the original estimate, and what confidence can we feel in its propounders? That the inhabitants of Gennevilliers have suffered a real, tangible injury from this application of one-tenth part of the dose originally intended has been established beyond all doubt by the investigations ordered by the tribunals. The level of the underground waters, which was formerly 4 metres below the surface, has been raised 2 metres. Cellars which were formerly invaded by the water only when the Seine rose exceptionally high are now regularly under water, and their floors have had to be raised till there is no longer room in them to stand upright. "It is certain," says the work before us, "that an important manufacturer like M. Pommier would not have amused himself by placing the boilers of his engines where the furnaces were perpetually invaded by water. It is certain that sand quarries were formerly worked at Gennevilliers, and that they were not worked under water." Yet these open and palpable facts were up to the last moment denied by the municipal engineers. Nor was the water purified as it was charitably hoped might be the case. The quality of the water in the shallow wells of the district has undergone a decided change for the worse.

We may here be permitted to mention a small observation of our own. No further back than November last we had occasion to perform some experiments upon Paris sewage, and we learnt that at a certain place in Gennevilliers, not far from the Bridge of Saint Ouen, we might obtain a supply without the delay and expense of obtaining official permission to break into a sewer. The water thus procurable had every character of somewhat stale sewage, and was especially rich in sulphuretted hydrogen; and after a careful examination we found it could have no other source save the sewage of Paris, after percolating through a stratum of soil of certainly not less than two yards in depth. As regards the salubrity of the district, it is not denied that intermittent fevers, though not of a malignant type, have become more frequent since the introduction of irrigation. The plot of land actually irrigated does not, however, exceed 300 hectares out of a total extent of at least 1000. Hence it becomes exceedingly probable that were the irrigated tract extended the injury to health would become more serious.

The inhabitants of Gennevilliers are unanimous in declaring that on a calm summer evening the odour diffused is decidedly offensive. Visitors who make a short inspection of the place in the middle of the day do not perceive this nuisance. Having made a stay of a fortnight we can affirm that the residents of the village are not mistaken. We can likewise bear testimony to the extreme and costly vigilance which prevails in the removal of all deposits of organic matter from the channels. The work before us enquires very naturally whether a similar vigilance would or could be kept up if the irrigation tract were larger and more remote from inspection? If irrigation can only be prevented from becoming a nuisance and a danger by such minute and costly watchfulness, are not its claims to general adoption *ipso facto* very much weakened?

We shall return to this subject, with especial reference to the agricultural phase of the Paris experiments, and to the circumstances which indicate that at St. Germain irrigation would be a far more serious mistake than it has been at Gennevilliers.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 10, March 8, 1880.

Chemical Stability of Matter in Sonorous Vibrations.—M. Berthelot.—The author has investigated the question whether the ordinary sonorous vibrations of ponderable matter can provoke decompositions and combinations? Many chemists admit that explosive bodies may detonate under the influence of certain musical notes, but this theory is not incontestably examined. M. Berthelot has made experiments with very deep sounds (vibration, 100 per second), and very acute ones (vibration, 7200 per second). Ozone, arsenic hydride, sulphuric acid, in presence of ethylen, oxygenated water, and persulphuric acid, have been exposed to these vibrations without sensible effect. Hence, the author concludes that matter is stable under the influence of sonorous vibrations, but is decomposed when acted upon by ethereal vibrations, which are much more rapid than those even of the acutest sounds.

New Remarks on the Formation-Heat of Gaseous Chloral Hydrate.—M. Berthelot.—The author points out that the recent experiments of M. Wurtz upon this subject have been made under unfavourable conditions. The pressure, 0·16 m., has been too low. In proportion as the pressure is reduced we approach a tension at which

no combination takes place, a circumstance which greatly reduces, if it does not annul, the heat developed under a normal pressure. The volume of the gases in reaction was likewise too small.

Comparison between the Tension Curves of Saturated Vapours (Second communication).—M. Paul de Mondesir.—Not susceptible of useful abstraction.

Action of Electrolysis upon Terebenthen.—Ad. Rénard.—Terebenthen, along with sulphuric acid, alcohol, and water, was submitted to the action of five Bunsen elements. Hydrogen was evolved at the negative pole. Among the products the portion distilling between 170° and 250° yielded a portion of terebenthen which had escaped the reaction, cymen boiling at 178° to 180°, and monohydrate of terebenthen, $C_{10}H_{18}O$, boiling between 210° and 215°. It may be considered as a pseudo-alcohol. The aqueous liquid separated from the mixture of cymen and of the mono-hydrate contains an acid, the sulpho-ethylic derivative of a hydroxyl-campholic acid, differing from campholic acid by an excess of 2(OH).

Synthesis of Aromatic Aldehyds: Oil of Cummin.—Chloride of chromyl attacks the group CH_3 in connection with the phenyl radical, and by the ulterior action of water transforms it into the COH, characteristic of the aldehyds. If cymen is treated with chromyl chloride in a sulpho-carbonic solution there is formed a brown granular precipitate, which, after decomposition with water and purification, yields a yellow oil, presenting all the properties of the cuminic aldehyd extracted from the ordinary essential oil of cummin.

Two New Silicates of Alumina and Lithia.—P. Hautefeuille.—One of these artificial silicates approaches oligoclase, whilst the other may rank with orthose and albite.

Phosphates and Boro-phosphates of Magnesia and Lime from the Guano Beds of Mejillones.—M. Domeyko.—Guanos from latitudes 23° to 24° S. retain merely a trace of nitrogen, and consist chiefly of phosphates. The boracic acid in one sample of boro-phosphate reached 11 per cent.

Composition of the Waters of Cransac (Aveyron).—E. Willm.—This water is chiefly remarkable as containing nickel. Manganese and zinc were present, but no copper.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. No. 19.

Conversion of Propyl-bromide into Iso-propyl-bromide.—A. Kekulé and H. Schrötter.—Normal propyl-bromide, carefully purified and boiled at 71°, was heated for some time in a cohobator with aluminium bromide and distilled off. The product, after purification, was found to be iso-propyl-bromide, boiling at 60 to 63°.

Fumaric and Maleic Ether.—R. Anschütz.—This paper contains an account of bibrom-succinic diethyl-ether, of bibrom-succinic methyl-ether, fumaric diethyl-ether, fumaric dimethyl-ether, maleic diethyl-ether, maleic dimethyl-ether, mono-brom-maleate of silver and the corresponding fumaric salt, mono-brom-fumaric dimethyl-ether, and mono-brom-maleic diethyl-ether.

The Mixed Azo-Compounds.—C. Kappeler.—An investigation of azo-nitro-methan-benzol and of certain analogous compounds.

On Nitroso-ethyl-methyl-keton.—H. Gutknecht.—An examination of certain bodies formed by the action of nitrous acid upon acet-ester.

On Bioxy-fumaric Acid.—S. Tanatar.—The author has oxidised fumaric acid with potassic permanganate, obtaining bioxy-fumaric acid, along with oxalic and carbonic acids in smaller proportions. Free bioxy-fumaric acid causes a turbidity or precipitate in the solutions of lime salts, even of the sulphate.

Certain Derivatives of the Three Toluylic Acids.—E. Ador and A. A. Rilliet.—Not adapted for useful abstraction.

Reply to Delachanal's and Mermet's Claims of Priority.—C. Fahlberg and W. Iles.—The dispute refers to a method for the determination of sulphur (*Berichte*, xi., 1187). The authors show that their procedure is not identical with that of MM. Dalachanal and Mermet.

A Lecture Experiment.—F. Kessel.—An account of a phenomenon observed on bringing sulphuretted hydrogen into contact with fuming nitric acid.

Dimethyl-naphthyl-amin and Naphtho-quinon.—P. Mounet, F. Reverdin, and E. Noelting.—Perfectly pure dimethyl-naphthyl-amin does not give, with ferric chloride and sulphuric acid, the coloured reaction described by Landshoff. In the hope of obtaining a tinctorial product analogous to methyl-violet, the authors submitted it to oxidation under similar circumstances, but obtained merely a blackish resin of a pungent odour. Other oxidising agents gave no better results.

Amido-acids with Alcohol Radicles.—Peter Griess.—The compounds here described are trimethylated amido-salicylic acid, oxy-benz-betain hydriodate and hydrochlorate, benz-betain periodide and perbromide.

Contribution to a Knowledge of the Ureides.—E. Mulder.—An account of certain derivatives of barbituric acid.

Decomposition of Vegetable Indican in the Absence of Air.—E. Schunck and H. Rœmer.—Vegetable indican, on decomposition by hydrochloric acid in the absence of air, gives neither indigo-blue nor indigo-white.

Decomposition of Rubianic Acid by Hydrochloric Acid in Presence of Mercury.—E. Schunck and H. Rœmer.—On subjecting rubianic acid to a similar treatment to that applied in their last experiment, the authors obtained two bodies which they are about to examine.

Spectroscopic Notes.—Hermann W. Vogel.—The author recommends chemists who have no Bunsen flame at command to use as a substitute the flame of hydrogen, with which he has succeeded in obtaining the spectra of the earths and alkalies. He also gives instructions for the detection of cobalt along with iron and nickel. Cobalt salts, dissolved in alcohol and mixed with potassic sulphocyanide, give a blue liquid with a most characteristic spectrum. This reaction became more important after Zimmermann had shown that the sulpho-cyanides of cobalt and nickel are precipitated by sodium carbonate, which the corresponding iron compound is not. Upon these facts the author founds the following method for detecting cobalt in presence of nickel and iron. The solution in which the iron must be present in the ferric state is mixed with an excess of ammonium sulphocyanide, and then with sodium carbonate, till the blood-red colour has changed to a yellow. The whole is then filtered and the filtrate shaken up in a test-tube with a mixture of equal volumes of amylic alcohol and ether. This mixture takes up the cobalt sulphocyanide from the aqueous liquid and floats on the top as a blue stratum, in which the absorption-band may be found between C and D.

The Oxidation of Para-sulph-amin-toluylic Acid.—Oscar Jacobsen.—Not suitable for abstraction.

Ethylated Mercuramin Compounds.—H. Kœhler.—An addendum to the author's paper (xii., 2208).

Ortho-tolyl-urethan, Ortho-tolyl-iso-cyanate, and Diortho-tolyl-urea.—R. H. C. Nevile and A. Winther.—A brief notice of the bodies named above.

Oxidation of Cholic Acid.—M. Kutscheroff.—None of the author's experiments upon the oxidation of cholic acid, whether amorphous or crystallised, have yielded fatty acids, which completely clashes with the results of Tappeiner.

The Third Pyridin-mono-carbonic Acid.—Z. H. Skraup.—Not suitable for abstraction.

Reply to H. Schiff with Reference to the latter's Remarks on his Researches on the Constitutional Formulæ of the Ferric Compounds.—D. Tommasi.—The writer complains that Schiff has misrepresented his views on the oxy-chlorides and basic nitrates of iron.

Certain Mono-chloro-crotonic Acids.—G. W. A. Kahlbaum.—An account of mono-chloro-tetracrylic acid, mono-chloro-crotonic acid, and mono-chlor-iso-crotonic acid.

Conversion of Piperidin into Pyridin.—W. Kœnigs.—This conversion is effected by oxidation.

Tinctorial Bodies of the Rosanilin Group.—E. and O. Fischer.—A very important paper, but quite incapable of useful abstraction.

Transformations of the Lævo-rotatory Terpen from French Oil of Turpentine by means of Hydration and Dehydration.—F. Flawitzky.—The author has obtained a lævo-rotatory iso-terpen.

Action of Sulphur upon Phenyl-Benzamid.—A. W. Hofmann.—An account of a new compound, benzenyl-amido-phenyl-mercaptan.

Bulletin de la Société Chimique de Paris, No. 4, Feb. 20, 1880.

Volumetric Determination of Active Oxygen in Barium Peroxide and Oxygenated Waters.—M. Armand Bertrand.—Already noticed.

Artificial Production of a Crystalline Iron Arseniate.—MM. A. Verneuil and Leon Bourgeois.—The authors have obtained scorodite by acting upon iron with a concentrated solution of arsenic acid at 140° to 150° in a sealed tube.

Reversion of Phosphates Soluble in Ammonium Citrate.—M. A. Colson.—The citrate does not dissolve the ammonia magnesium phosphate, though this body is slightly soluble in water. Bicalcic phosphate prepared under certain conditions leaves up to 73 per cent of its weight undissolved in the citrate. Certain superphosphates prepared with the siliceous ores of Vaucluse underwent a rapid reversion, losing in a fortnight from 10 to 15 per cent of soluble phosphate. The author considers that this change is due to the sulphate of lime, which removes water of hydration from the assimilable phosphates and renders them to a great extent insoluble in the citrate. Superphosphates prepared with phosphoric acid revert but slightly and slowly, whilst those prepared with sulphuric acid undergo a greater reversion the more considerable the proportion of the latter.

Preparation of Pure Levulose.—M. Ch. Girard.—Not suitable for abridgment.

Reactions Produced by Aqueous Dimethylamin upon Metallic Solutions.—M. Camille Vincent.—With neutral magnesium salts there is formed a white precipitate insoluble in excess. With the salts of glucinum and zirconium the results are similar. Aluminic salts give a white precipitate soluble in excess. Ferrous salts give a dirty white precipitate, and ferric salts an ochre-brown, both insoluble in excess. The green chromic salts give a green precipitate and the violet modification a greenish-grey, both insoluble in excess. Manganese salts give a white precipitate which rapidly turns brown on exposure to the air. The presence of sal-ammoniac prevents the precipitation. Cobalt salts give a blue-grey precipitate and nickel salts an apple-green, both insoluble in excess. Uranic salts give a yellow precipitate insoluble in excess. Zinc salts give a white precipitate soluble in excess. Cadmium salts give a white precipitate insoluble in excess. The salts of tin all give white precipitates, the stannous being insoluble and the stannic soluble in excess. Antimony: the salts of Sb_2O_3 give a white precipitate insoluble in excess and those of Sb_2O_5 also a white precipitate soluble in excess. Bismuth gives a white precipitate insoluble in excess, as do all the soluble salts of lead. Copper salts give a blue precipitate, which is turned deeper by an excess but does not dissolve. Mercurous salts give an insoluble black precipitate and mercuric salts a white precipitate, insoluble in excess, but soluble in much water. Silver salts yield a deep grey precipitate, soluble in excess. Dimethylamin dissolves silver chloride. Concentrated palladic solutions give a brown precipitate soluble in excess and forming a brown liquid which turns to a light yellow. Auric chloride gives a yellow precipitate, soluble in excess and forming a deep brown liquid. Platinum chloride forms an orange-yellow precipitate of a double salt soluble in water.

Russian Chemical Society, Session of March 1/13, 1879.—M. Lagermark sent in a memoir on the synthesis of tetrolic acid. The same chemist, in conjunction with M. Eltekoff, presented a paper on the synthesis of pyroterebic acid. M. Beketoff explained his process for determining the hydration-heat of sodium protoxide. M. Flavitzky has obtained from French oil of turpentine a terebenthene whose rotatory power, $[\alpha]\ D = 43{\cdot}4°$. M. J. Goldstein explained the theoretic manner of calculating the boiling points of the saturated hydrocarbons of normal structure. M. Latschinoff announced that he had been for three years engaged with the study of the oxidation of cholalic acid by permanganate.

Chemiker Zeitung. No. 5, 1880.

The Phosphorus Question.—The author points out the injurious character of the match manufacture where the ordinary or white phosphorus is in use, and considers that the sanitary precautions adopted in various establishments are utterly useless. The loss from fires, occasioned by the careless use of matches, in Germany alone, for the ten years 1862 to 1871, is calculated at £900,000.

Separation of Gold by Quartation with Zinc.—C. A. M. Balling.—The author criticises Jüptner's method (*Zeitschrift für Anal. Chemie*, 1879, p. 104), and points out certain defects. On melting the zinc with the alloy in an open porcelain crucible the former is partially oxidised, the film of oxide hindering the contact of the metals. If the fusion is performed under a layer of resin, the vapours become ignited and the resin is often burnt away before the fusion is effected. Even in a covered crucible the resin is also soon volatilised, whilst particles of carbon are deposited on the lid and the sides, and falling back into the crucible contaminate the alloy. The finer particles of carbon render the solution in nitric acid turbid and cannot be entirely removed by washing. The author, therefore, modifies the process as follows:—He used cadmium, which is more readily fusible for quartation, instead of zinc, and takes potassium cyanide as a cover. The metals unite readily under the melted cyanide at the heat of a Berzelius spirit-lamp and a homogeneous regulus is soon obtained. The crucible, when cold, is placed in a beaker and the potassium cyanide is dissolved in water. The solution is poured away and the metal is washed with water. It is then introduced into a flask and boiled once with nitric acid of specific gravity 1·20 and then thrice with nitric acid of specific gravity 1·30. The cadmium is completely dissolved. Two and a half parts of this metal suffice for quartation. The granule of gold retains the form of the original metal and is transferred to a small crucible for ignition.—*Oest. Zeitschrift Berg. u. Hüttenw.*

Determination of Sulphur in Pyrites.—R. Fresenius.—The precipitation of barium sulphate in boiling solutions does not take place instantaneously. Appreciable quantities remain at first in solution. If the solution contains ferric chloride, this has, on the one hand, a solvent action upon the barium sulphate, which, on the other hand, always appears red after ignition, and the ferric oxide producing this colour cannot be removed by treatment

with hot hydrochloric acid. These two sources of error act in opposite directions, but the solvent action of the hydrochloric acid and the ferric chloride preponderates. In an examination of Lunge's process (precipition of the boiling liquid containing ferric chloride and some hydrochloric acid with boiling barium chloride and immediate filtration) Fresenius has obtained deficiencies of 1 to 1·7 per cent in a pyrites containing 43·8 per cent of sulphur, as ascertained by his own method (*Zeitschrift Anal. Chemie*, xvi., p. 339).—*Zeitschrift Anal. Chemie*, xix., p. 53.

NOTES AND QUERIES.

Valuation of Soda-Ash.—The formulæ given below will show in what proportion to mix a strong and a weak ash, so as to obtain one of a given intermediate strength. Let a, b, and c = percentage of alkali in strong, weak, and intermediate ash, respectively; W=weight required of strong ash, and w=weight required of weak ash. Then—

$$W=\frac{c-b}{a-b}, \text{ and } w=\frac{a-c}{a-b}.$$

An example will make this clear:—Suppose it is desired to find what weight of strong ash at 52 per cent, when mixed with ash at 12 per cent, will be required to make a ton of ash at 34 per cent. Then—

$$W=\frac{c-b}{a-b}=\frac{34-12}{52-12}=\frac{22}{40}=\frac{11}{20}.$$

Therefore 11 cwts. at 52 per cent and 9 cwts. at 12 per cent will produce 1 ton of 34 per cent ash.—Edward Jackson.

MEETINGS FOR THE WEEK.

Monday, 12th.—Medical, 8.30.
—— Royal Geographical, 8.30.
—— Society of Arts, 8. Robert W. Edis, F.S.A., "The Decoration and Furniture of Town Houses."
Tuesday, 13th.—Civil Engineers, 8.
—— Photographic, 8
—— Anthropological Institute, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Royal Institution, 3. Prof. Huxley, "Dogs and the Problems Connected with them."
Wednesday, 14th.—Society of Arts, 8. Henry B. Wheatley, F.S.A., "The History and Art of Bookbinding."
—— Microscopical, 8.
—— Geological, 8.
Thursday, 15th.—Royal Society Club, 6.30.
—— Royal Institution, 3. Prof. Tyndall, "Light as a Mode of Motion: Theories of Light and Colour."
—— Royal, 8.30.
—— Chemical, 8. Dr. Mills, "On the Lecture Illustration of Chemical Curves." W. H. Perkin, F.R.S., "On the Analysis of Organic Bodies Containing Nitrogen (continued).
Friday, 16th.—Royal Institution, 8. M. Ernest Renan, "Marcus Aurelius," 9.
—— Society of Arts, 8. Prof. Vambery, "Russia's Influence over the Inhabitants of Central Asia During the Last Ten Years."
Saturday, 17th.—Royal Institution, 3. Mr. James Sully, "Art and Vision."

TO CORRESPONDENTS.

J. H.—For the best account of Spence's metal, see Chemical News, vol. xli., p. 87.

ROYAL POLYTECHNIC.—Lectures on the Phenomena of Nature, illustrated by Dissolving Views and Experiments, by Mr. J. L. King. Arctic Exploration, its History and Prospects, by Mr. W. R. May. Balmain's Luminous Paint, or a Trap to Catch a Sunbeam. Wonderful New Automatic "Blondin," which will traverse the whole length of the Hall on a rope suspended thirty feet from the floor. Tableaux Vivants of events in the life of Mary Queen of Scots; the descriptive poem by Bell, read by Miss Alice Burnelle, the character of Mary impersonated by Miss Eva Russell. New Ghost Piece, written by Ellis Reynolds, entitled The Magician Foiled. Also, Leotard the Automaton, the Diving Bell, the Electric Organ, Going Machinery, and many Novelties. Open from 10 till 1, 2 till 5, and 6 till 10; for times of Entertainments see daily papers. Admission, 1s. Reserved Seats, 2s., 1s., and 6d. extra.

THE JOURNAL OF SCIENCE
for April (Price 1s. 6d.), includes—
Our Friends and how we Treat them.
Organic Synthesis and its Social Bearings.
Instinct and Mind. By S. Billing.
Modern Advances in Meteorology
The Rate of Animal Development. By J. W. Slater.
On Water and Air. By Prof. Tyndall, D.C.L., LL.D., F.R.S. (Lecture IV.) Illustrated.
Analyses of Books. Correspondence. Notes.
London: 3, Horse-Shoe Court, Ludgate Hill.

SPECIALITIES.

MANGANESE Finest Crystallised, Lump, Ground, and Granulated of every quality, and Prepared for *Chlorine, Glass, Steel, Ferro-Manganese Pottery, Battery*, and Every Purpose.

BAUXITE (Hydrate of Alumina) Of high percentage o Alumina and almost free from Iron. The Cheapest, Best, and Most Profitable article from which to produce Alum, Alum Cake, and Sulphate of Alumina, &c. [BRAND, "IRISH HILL BAUXITE."]

FLUOR-SPAR Of the Very Finest Quality for Acid, Soda, Glass Flux, and all purposes.

BARYTES (Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

CRYOLITE, Magnesite, Felspar, Arsenic, Phosphates French Chalk, Strontia, Wolfram, Chrome, Terra Alba, Rotten Stone, China Clay, Umbers Ochres, Antimony, Calamine, Emery Stone all Oxides, and all

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,
MINE PROPRIETOR,
Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.
OFFICES—26 CHAPEL STREET, LIVERPOOL.

Established 1798.

ROBERT DAGLISH & CO.,
ENGINEERS, BOILER AND BRIDGE MAKERS, MILLWRIGHTS,
BRASS AND IRON FOUNDERS.

Manufacturers of every description of Condensing, or High-pressure Blowing, Pumping, Rolling, Winding, and Patent Steam-engines of any required power, for Irrigating, Draining, Mining, Rolling Mills, or Water Works purposes, and Manufacturers of every description of Chemical, Colliery, Copper Ore, Gold Mining, Glass, and Rock-salt Machinery.
Black-ash Revolving Furnaces of the Most Approved Type.
Bessemer Steel-Rail Plant.
Compressing-Engines for Collieries, Iron Works, and Weldon Patent Bleaching-Powder Process.
Caustic, Chlorate, Decomposing, Nitre, Nitro-Glycerine, Iodine Potash, Sulphur, Acid, and Oxalic Pans.
Gas Producers Patent for Heating and other Purposes.
Pyrites Burners for Irish, Norwegian, and Spanish Ores of Improved Construction.
Patent Rousing Machinery for Brewers.
Retorts, Acid, Gas, Iodine, Nitric, Nitre, Nitro-Glycerine and Vitriol Refining.
Steam Superheaters improved for Oil, Tar, and Resin Refining.
Steam Sulphur Melter.
Stills for Oil, Resin, and Tar.
Wheels, Bevel, Mitre, and Spur Moulded on the Shortest Notice by Patent Machinery.
Makers of Mactear's Patent Carbonating Furnace, Jones and Walsh's Patent Sulphate of Soda Furnace, Parnell and Simpson's Patent Causticiser, and Kynaston's Patent Alum Plant.

Lists sent on Application.

Photographs, Plans, and other information supplied on receipt of Order.

ST HELEN'S ENGINE, BOILER, AND BRIDGE WORKS AND FOUNDRY,
LANCASHIRE.

THE CHEMICAL NEWS.

VOL. XLI. No. 1064.

BETORCINOL AND SOME OF ITS DERIVATIVES.

By J. STENHOUSE and CHARLES E. GROVES.

(ABSTRACT.)

ABOUT thirty-two years ago, in the course of an extended examination of the lichens with regard to the organic compounds contained in them, and derivatives of these compounds, a quantity of the crude usnic acid obtained from *Usnea barbata* and *Cladonia rangiferina* was submitted to destructive distillation. The distillate was found to contain a crystalline substance of the composition $C_8H_{10}O_2$, homologous with orcinol and very closely resembling it in most of its properties. This new member of the orcinol group was named β-orcin, and as it was known that the erythrin and lecanoric acid from the *Rocellas* and the *Lecanoras* yielded orcinol, it was somewhat hastily inferred that the usnic acid in the *Usnea* and *Cladonia* was the source of the so-called β-orcin. Subsequent attempts to prepare the β-orcin by the distillation of pure usnic acid from *U. barbata* yielded negative results, not a trace of the orcinol could be detected.

As there were not only many points of interest connected with this higher homologue of orcinol, but also great uncertainty as to what was the real source of the compound, a quantity of *U. barbata* was obtained from two different localities in Scotland, and carefully freed from every trace of evernia or other lichen. The crude usnic acid extracted from this usnea was submitted to destructive distillation, and the distillate examined for the orcinol by means of chloride of lime solution. The crimson-red colouration produced at once showed that the usneas from both localities contained the orcinol-yielding compound: it remained to determine whether this was the usnic acid or some other principle accompanying it in the lichen. Destructive distillation of the carefully purified usnic acid at once settled this point; not a trace of the β-orcin could be discovered in the distillate. There could no longer be any doubt, therefore, that the usnic acid was not the source from which the β-orcin was derived, but another substance accompanying it in the lichen in the same way that evernic acid accompanies usnic acid in the *Evernia prunastri*.

Betorcinol,* $C_8H_{10}O_2$ or $C_6H_2Me_2(OH)_2$. In order to prepare this member of the orcinol series, *U. barbata*, which has been carefully freed from every particle of evernia or other lichen which may be present, is exhausted with milk of lime in the usual way, and the crude acids thrown down on adding hydrochloric acid to the lime solution, are boiled with lime and water for some hours, taking care to exclude the air so as to avoid oxidation. The clear solution separated from the insoluble basic calcium usnate is at once neutralised with hydrochloric acid and evaporated as far as possible on the water-bath, when the crude betorcinol crystallises out, being almost insoluble in concentrated solutions of calcium chloride. It is purified by successive crystallisations from benzene and from water. The crystals were found to have the same melting-point, 163° C., as the original specimen prepared thirty-two years ago, and to be identical with it in its chemical properties. Betorcinol differs from orcinol not only in the melting-point and in being much less soluble in water, but also in its chemical reactions, especially with hypochlorites and with ammonia. Betorcinol gives a characteristic bright crimson colouration with hypochlorites very different from the purplish red obtained with orcinol. The ammoniacal solution, moreover, becomes rapidly coloured on exposure to the air, whilst the corresponding orcinol solution is but slowly changed.

Chloro-betorcinols.—Betorcinol yields two chlorinated derivatives, both of which are colourless crystalline substances.

Tetra-chloro-betorcinol, $C_8H_6Cl_4O_2$, is easily prepared by adding a solution of the orcinol to chlorine hydrate, taking care to keep the latter in excess, and crystallising the product from light petroleum. It forms large prisms (m.p. 109°), which are readily converted into *dichloro-betorcinol*, $C_8H_8Cl_2O_2$, by the action of hydriodic acid; this crystallises from light petroleum in long colourless needles (m.p. 142°).

Bromo-betorcinols, corresponding with the two chloro-betorcinols, have been prepared and examined. *Tetra-bromo-betorcinol*, $C_8H_6Br_4O_2$, is obtained in a manner somewhat similar to the chlorinated derivative by adding betorcinol solution to a mixture of bromine and water, keeping the bromine in excess. It crystallises from petroleum in large colourless prisms (m.p. 101°), which are converted into *dibromo-betorcinol* by the action of hydriodic acid. The dibromated derivative is much more easily prepared, however, by acting on betorcinol with the requisite proportion of bromine diluted with carbon bisulphide, and crystallising the product from carbon bisulphide and from petroleum. It forms long colourless needles (m.p. 155°).

Moniodo-betorcinol, $C_8H_9IO_2$, is a colourless crystalline compound, obtained by the action of lead oxide in excess on an ethereal solution of betorcinol and iodine in a manner precisely similar to that employed in the preparation of moniodorcinol. It is only very sparingly soluble in boiling water, and crystallises out on cooling. Its melting-point is 92°.

Mono-nitroso-betorcinol, $C_8H_9(NO)O_2$, is thrown down as a bright red precipitate on pouring an aqueous solution of betorcinol into a mixture of nitrosyl sulphate and water. It is soluble in hot water and easily soluble in spirit, but cannot be crystallised from these menstrua. It is also soluble in hot glacial acetic acid, and on cooling separates in minute prismatic crystals of a brilliant crimson colour. All attempts to obtain a crystalline nitro-derivative of betorcinol were fruitless, whether by the oxidation of the nitroso-compound or by the direct action of nitric acid on betorcinol. In each case nothing but amorphous flocculent substances were produced.

The Acid which yields Betorcinol.—As the crude mixed acids from the usnea contain but a very small quantity of this acid in proportion to the usnic acid, great difficulties were experienced at first in separating the two, and it was not until after many fruitless trials that a process was discovered which permitted the new acid to be isolated with certainty. The method is founded on the difference in the solubility of the two acids in benzene and in ether respectively, the new acid being much more soluble in cold ether than usnic acid is. It crystallises from benzene in colourless needles or long plates, and sometimes in short prisms. It melts at 186°, and at a somewhat higher temperature decomposes with evolution of carbonic anhydride and formation of betorcinol. The analyses of this acid correspond with the formula $C_{19}H_{20}O_7$, which has the same relation to betorcinol that evernic acid, $C_{17}H_{16}O_7$, has to orcinol. As, however, it cannot be considered to be definitely decided that it is a dimethyl-evernic acid, it has been named provisionally *barbatic acid* from the circumstance of its existing along with usnic acid in the *U. barbata*.

By treating an usnea found growing on Calisaya bark with lime and dilute alcohol, Hesse succeeded in obtaining an acid of melting-point 172°, which he termed usnetic acid. Although this acid resembles barbatic acid in many of its properties, the much lower melting-point and the

* As the prefix α and β is now almost universally employed to distinguish isomerides, it has been thought advisable to change the name of this homologue of orcinol from "β-orcin" to betorcinol.

higher percentage of carbon in the former (about 1·7 per cent), renders it improbable that the two are identical, especially as he states that when heated it gave no sublimate. It is well known that the lichen acids derived from orcinol, such as lecanoric and evernic acids, yield ethereal salts with the greatest readiness when boiled with alcohol, and a knowledge of this fact made the authors studiously avoid the use of alcohol in the preparation of barbatic acid, whilst Hesse not only employed dilute alcohol to extract the mixed acids from the lichen, but purified his usnetic acid by dissolving it in hot dilute alcohol and evaporating the solution.

ON NASCENT HYDROGEN.

By Dr. D. TOMMASI.

I HAVE just received from the Secretary of the Dutch Society of Sciences at Harlem, the original memoir by Dr. Phipson on catalytic force. My first duty is to sincerely thank Prof. von Baumhauer for the kind manner in which he remembered to send me Dr. Phipson's memoir. I have read the work with much interest, and, although I do not share Dr. Phipson's opinions in any degree, I cannot do less than compliment my honourable adversary on the manner in which he has treated so difficult a question as catalytic force, a method which is as clear as it is profound.

Dr. Phipson takes hardly any notice in his memoir of anything but catalytic force; as to the question of the nascent state, he only glances at it. Catalytic force takes up 34 pages of the memoir, and Dr. Phipson only devotes about half a page to the nascent state of matter. Here is what he says in this half page:—

"We know since chemistry has existed as a science, how great an influence the *nascent state* of a body has on the compounds it can form; one such compound is *only* possible when one of its constituents is in the nascent state; another, only when both the bodies which form it are in this state. What is called the "nascent state" is, I think, nothing more or less than the allotropic state of bodies entering into combination; it is already some time since I published this idea. M. Houzeau seems to be of the same opinion as myself. Considering these facts, it seems incontestible that *every time oxygen enters into or leaves compounds it is in the state of ozone.* When we reflect further on the results already obtained with hydrogen, chlorine, bromine, sulphur, and phosphorus, we are inclined to believe that all the simple bodies should behave in the same manner; that is to say, that all bodies may have an allotropic state analogous to ozone, and that they are in this state at the moment of entering into combination, or when they are in the *nascent state.*"

See, now, what I have said about nascent hydrogen:—

"If hydrogen in the nascent state is endowed with a greater affinity for other bodies than it has in the ordinary condition, it is simply because hydrogen at the moment of leaving a compound is accompanied by a large quantity of heat, which is generated during its being set at liberty. Therefore nascent hydrogen is nothing more than ordinary hydrogen under different physical conditions. In my opinion, nascent hydrogen is merely hydrogen + heat. In fact all the reductions which are produced by nascent hydrogen can be obtained equally well with ordinary hydrogen and a higher temperature. And the differences which are observed between the hydrogens produced by different chemical reactions, are caused by these reactions not all developing the same amount of heat."

Now, I ask what resemblance can there be between the explanation put forward by Dr. Phipson and that given by myself?

How could Dr. Phipson say that my theory on the nascent state was the same as that which he made known in 1858, with this single difference, that in the place of "electricity" I put "heat," while, speaking of the nascent state in his memoir, Dr. Phipson *does not once use the word "electricity"?*

What are the experiments which Dr. Phipson has made to prove that nascent hydrogen is not hydrogen accompanied by heat or electricity, but hydrogen in an allotropic state similar to ozone, as he pretends? None, that I know of.

Again, I was the first to give a precise and scientific definition of what nascent hydrogen is, and I was also the first to collect a sufficient number of facts to form the basis of a theory. I have given up two entire years to the study of nascent hydrogen, I have published ten memoirs on this subject, and I have made a very large number of experiments. I should also like to make some observations on the manner in which Dr. Phipson explains the phenomena formerly known as catalytic, but as this would be a deviation from the subject of the present note, I reserve my observations for a future time.

DETECTION OF HYDROCHLORIC ACID BY SULPHURIC ACID AND ACID POTASSIUM CHROMATE.

By H. W. WILEY.

THIS well-known test is more conveniently made in the following way than by distillation in a retort as usually directed. Two small beakers are taken, of different sizes, the smaller of which will fit into the larger, leaving a space of two or three centimetres between the two bottoms. The chloride and chromate are well rubbed together, and placed in the larger beaker, care being taken that none of the particles touch the sides of the vessel. A few drops of H_2SO_4 are added, and the smaller beaker then put in place. A lump of ice, and if necessary a little salt, are then placed in inner beaker. The (so-called) chloro-chromic acid is given off at a very gentle heat (do not boil), and is readily condensed on the cold surface of the beaker. If there is more than a mere trace of chloride a watch-glass can be substituted for the smaller beaker.

After the reaction has ceased the inner beaker is removed, and the usual test, $[(H_4N)OH]$, is applied. I extend and modify this in the following way:—

(1.) After adding a drop of $(H_4N)OH$ to the CrO_2Cl_2 (still on bottom of inverted beaker) $HC_2H_3O_2$ is added in excess. A drop solution of $Pb(C_2H_3O_2)_2$ then is added: $PbCrO_4$ is precipitated. This will detect HCl when so little is present that the change of colour with $(H_4N)OH$ is not perceptible.

(2.) This is an easier and far more delicate process. In fact it seems quite as sensitive and far more striking than the test with silver nitrate. The CrO_2Cl_2 is prepared as above. With a stirring-rod a very little H_2SO_4 is placed on a white porcelain surface and near by a minute crystal of strychnia. The end of the stirring-rod is then moistened with the CrO_2Cl_2, and brought in contact with the H_2SO_4 and strychnia. The colour test for strychnia is developed with even greater brilliancy than with $K_2Cr_2O_7$: the merest trace of a chloride is most unmistakeably revealed by this test. If bromides are present they do not at all interfere with the above reaction. Bromine itself with strychnia and H_2SO_4 gives no play of colours. Bromides, moreover, when present, can usually be detected at the same time with the chlorides. The bromine formed is readily condensed, and forms either distinct globules or imparts a deeper colour to the CrO_2Cl_2.

With iodides the case is quite different. In many cases I have found no trace of CrO_2Cl_2 when both chlorides and iodides were present. At other times the iodine which is set free seems to be dissolved in the CrO_2Cl_2. In such cases, on adding $(H_4N)OH$ to the reddish yellow distillate, the whole mass turns black, from the formation of iodide of nitrogen. On filtering this off the reactions for CrO_2Cl_2,

or the chromate formed from it, can be obtained in either of the ways specified above, but not with the same exactness as when iodides are entirely absent. The iodide of nitrogen on the filter-paper when dried will explode spontaneously, even when present in exceedingly minute quantities. It appears to be a much better (*i.e.*, more explosive) article than when prepared in the usual way.

I have yet to investigate the order of succession of the phenomena above mentioned as influenced by varying proportions of the several substances in the test employed. I have not been without a suspicion that bromides might possibly give rise to a trace of CrO_2Br_2 when treated as described. I have not, however, been able to procure an absolutely pure bromide with which I might determine the matter by experiment. All the authorities, however, whom I have consulted agree that only pure bromine is formed. The bromides I have tried all give faint reactions by the strychnia test, but I cannot say that they do not contain a trace of chloride. If someone in possession of an absolutely pure bromide would make the experiment the result would be of interest.

I am still investigating the anomalies produced in the chloride reaction with H_2SO_4 and $K_2Cr_2O_7$ by admixture of oxides.

Lafayette, Indiana, U.S.A.

ON DETECTION AND ESTIMATION OF ARSENIC.

By T. D. BOEKE, D.S.,
Laboratory of the High Burghal School at Alkmaar, Holland.

It is a well-known fact that the "white arsenic" and other arsenical compounds are extensively used for many purposes—*e.g.*, as a sheep-wash, as a means to prevent the growth of fungi in damp rooms, &c. The highly poisonous character of arsenical compounds has led in many countries to legal measures in order to prevent their being procured for criminal purposes. Yet it would seem as if really effective means to prevent their abuse are scarcely possible without actual prohibition. In Holland, at least, though the sale of 'white arsenic" is only allowed under special conditions, poisoning by this compound is by no means a rarity. In not less than seven cases submitted to me for analysis white arsenic proved to be the agent which had produced death in six cases, and in one of them severe and painful illness.

As in all of them not only the quality but also the quantity of the poison formed the object of enquiry, I had ample occasion to become acquainted with the advantages and disadvantages of the existing methods of search and estimation. The following remarks about the detection and estimation of this element in cases of poisoning may perhaps prove useful to those that are called on to make similar experiments:—

I. *Detection of Arsenic in Organic Mixtures.*

The admirable method of James Marsh, at least in its present improved form, allows the detection of the minutest traces of arsenic, even in the most complicated mixtures, with such a degree of certainty and ease that it seems wholly unnecessary to use other methods, *e.g.*, that of Fresenius and Babo,* or that of Reinsch.† However, with one restriction, viz., that the solution to be examined be *wholly* free from organic matter. This may be attained in two ways:—

(1.) By deflagration of the well-dried matter by means of a mixture of saltpetre and soda.

(2.) By heating a little bit of the matter to be examined, whether solid or liquid, with strong sulphuric acid and a few drops of nitric acid till the mass is wholly converted into a porous coal. Addition of some scraps of filtering-paper (which should of course be free from arsenic) greatly quickens this reaction.

If this residual coal, after evaporation of the superfluous sulphuric acid, be carefully extracted by boiling water, and the formed sulphurous anhydride which it contains be totally driven out by boiling, a perfectly colourless liquid is obtained, which is generally quite free from organic matter.

It cannot be denied that minute traces of arsenic by both modes of treatment may escape detection; in the former case by volatilisation of metallic arsenic during the charring that precedes the deflagration; in the latter by volatilisation of some arsenious chloride formed by reaction of the chlorides present in the organic matter on the sulphuric acid. However, I prefer the latter method to the former, as the presence of the nitric acid during the possible evolution of hydrochloric acid in the then *fluid* mass greatly diminishes the chance of arsenious chloride being formed and driven out. Never, indeed, have I failed to detect by this treatment even the faintest traces of arsenic in organic masses; for instance, a few c.c. of blood of a poisoned victim, a minute portion of ground coffee containing "white arsenic," &c.

As for the experiment of Marsh itself, the precautions to be taken in making it are so amply described in many handbooks on toxicology (among which that of Dragendorff ought to be mentioned in the first place), that it may seem superfluous to allude to them here.

Among the numerous reactions to ascertain the presence of hydride of arsenic or of antimony, or of both, in the gas obtained, that of Lassaigne* ought never to be omitted. The black precipitate of silver being filtered off, addition of very diluted ammonia or natrium acetate (Avery†) to the filtrate occasions the very characteristic yellow silver arsenite to be formed. If the black precipitate containing the silver be treated, after Hoffmann,‡ with tartaric acid, the presence of antimony is easily detected by means of sulphuretted hydrogen. Still better results are to be had by Pettenkofer's reaction‖ as it has been completed by Fresenius§ (heating of the obtained metallic rings in a slow current of sulphuretted hydrogen, and afterwards in a current of hydrochloric acid gas).

To ascertain if the metallic spots obtained on porcelain consist of arsenic or of antimony, I prefer calcium hypochlorite to the "eau de Javelle" recommended by Wachenroder,¶ as the latter often contains free chlorine, and in that case may dissolve antimony too.

Treatment of the spots with nitric acid (Dulk**) leads to safe results only if the evaporation of the nitric acid be effected with the utmost care.

If the above-mentioned reactions are carefully applied it is almost impossible that even the faintest traces of arsenic, or of antimony, or of both elements escape detection.

Estimation of Arsenic in Organic Mixtures.

Numerous are the means that have been proposed to convey the arsenic in organic mixtures into a compound which is fit to be used for its estimation. Experience has taught me that *variis modis bene fit* is here applicable; still I am of opinion that the following method, that I composed from well-known facts, combines an easy application and accurate results. The substance is heated on a water-bath with hydrochloric acid and potassic chlorate till it has assumed a liquid form (Fresenius and Babo, *l.c.*). Total solution by this means is never attained, as the chloranil (tetrachlorchinon), which is formed by the action of the nascent chlorine on the albuminoid matter, is only partly dissolved. When cold the acid liquid is filtered,

* *Ann. der Chem. und Pharm.*, xlix., 287.
† *Journ. fur Prakt. Chem.* xxiv., 244.

* *Journ. de Pharm.*, 1841, p. 52.
† *Silliman's American Journal*, xlvii., p. 253.
‡ *Ann. der Chem. und Pharm.*, cxv., p. 287.
‖ *Pharmac. Centralbl.*, 1842, p. 551.
§ *Ann. der Chem. und Pharm.*, xliii., p. 361.
¶ *Arch. d Pharm.*, (2), lxx., p. 14.
** *Arch. d. Pharm.*, xxxiv., 263.

and the residue on the filter washed till the acid reaction has nearly disappeared. This residue, if properly washed, never contains a trace of arsenic, as I had often the occasion to ascertain. The yellow filtrate is saturated (preferably in a wide-mouthed jar standing in a basin) with sodic carbonate (of course free from arsenic) till the reaction is strongly alkaline, and the liquid, whether turbid or not, is evaporated on a water-bath till the sodic chloride that it contains begins to crystallise out. By this evaporation it is greatly reduced in volume, so that even when kilogrammes of the organic matter have been treated in this way, generally not more than half a litre remains. During the evaporation it turns quite dark, and ammonia and amines escape from it. It is treated again with hydrochloric acid and potassic chlorate, filtered when necessary, and saturated with ammonia. Addition of the magnesic mixture causes all the arsenic which it contains to be precipitated as ammonio-magnesic arseniate, together with ammonio-magnesic phosphate. If this precipitate be filtered off after twenty-four hours, the separation is so complete that not the faintest trace of arsenic may be detected in the mother-liquor when treated afterwards by sulphuretted hydrogen.

In a comparatively short time it is possible by this method to collect all the arsenic contained in the most disgusting putrescent animal matter in the form of a well-crystallised compound. After being washed with dilute ammonia (1 to 10*) till the chlorine reaction has disappeared, it is almost quite white.

As it contains sometimes about half its weight of phosphate, and often some calcic sulphate, both derived from the animal substances, merely drying and weighing are not sufficient to reveal the quantity of arsenic it contains.

The best way of treating it further is to dissolve it in dilute sulphuric acid (1 to 5) and to reduce the arsenic pentoxide to trioxide by addition of sodic sulphite. After total expulsion of the sulphurous anhydride by boiling, the arsenic is precipitated by sulphuretted hydrogen.

If the magnesic double salts obtained have been sufficiently pure, the arsenical trisulphide prepared from it is quite free from uncombined sulphur and organic matter, and may be dried and weighed. If not, it is previously heated with strong sulphuric acid and some drops of nitric acid (Gautier†). In co-operation with Mr. H. J. Hamburger I have tried this method on blood mixed with known quantities of arsenic (doses of 3 to 5 grains, as these are generally deemed mortal ones), and compared it with the method that Otto describes in his "Ausführliches Lehrbuch der Anorg. Chem, 4°, Aufl. III., p. 594.

First Experiment.—267 grms. of blood containing 0·1133 grms. of pure As_2O_3 was treated with HCl and $KClO_3$. The filtered liquid was divided into two equal parts. The former part was treated subsequently for ten hours, then for two, and at last for seventeen hours more with sulphuretted hydrogen. Still the filtrate, as I noticed afterwards, contained arsenic. Only 0·05 grm. of pure As_2S_3 was collected, so that only 71·1 per cent of the added arsenic trioxide were found. The latter part was treated after my method. The crude magnesic precipitate obtained, after having been dried at 105° C., weighed 0·2071 grm., and the pure As_2S_3 prepared from it 0·065 grm., corresponding to 0·0523 grm. of As_2O_3, which proved that 92·4 per cent of the added arsenic trioxide had been found. As from the latter only 0·1025 ammonio-magnesic arseniate could have been formed, the crude precipitate in this case consisted for more than half its weight of phosphate.

Second Experiment.—750 grms. of blood were mixed with 0·3102 grm. of pure As_2O_3, and treated after my method. The crude magnesic precipitate was not weighed but dissolved, still moist, in diluted sulphuric acid, and the solution diluted to 250 c.c. 100 c.c. of this solution gave 0·1573 grm. of pure As_2S_3; another portion of 100 c.c. gave 0·1540 grm. These results proved that in the former part 0·3165, in the latter 0·3097 grm. of As_2O_3 had been found, *i.e.*, respectively 102 and 99·9 per cent of the added quantity.

Third Experiment.—To 1 kilogrm. of blood were added 0·32885 grm. of pure As_2O_3, and the mixture treated scrupulously according to Otto's indications. The clear solution in hydrochloric acid took a volume of 2·39 litres. In one litre of it the arsenic was determined. The total precipitation of all the arsenic trisulphide by sulphuretted hydrogen took several days. The treatment of the crude sulphide after Meyer proved to be a very tedious and lengthy operation. At last the arsenic was weighed as ammonio-magnesic arseniate. This weighed 0·24395 grm., which indicated that 97 per cent of the added As_2O_3 had been found.

This last experiment proves that very fair results may be obtained also by Otto's method when strictly followed. But in this case it takes a good deal of time and trouble. Moreover, it has one serious disadvantage that I escaped by my method, viz., the large quantities of sulphuretted hydrogen that are required. More than one examiner has pointed out the danger of introducing arsenic by using for the evolution of this gas the common ferric sulphide and acid of trade, as they generally contain more or less of this element. But even in using materials quite free from arsenic it is very difficult to note the point when all the arsenic is precipitated by the sulphuretted hydrogen. For this reason I think I may safely recommend my method in cases in which arsenic in organic mixtures is to be determined.

* Probably by a mistake Fresenius in the last, not yet complete, edition of his "Anleitung zur Quant. Chem. Analyse," p. 369, prescribes ammonia of 1 to 3! This is much too strong and dissolves an appreciable quantity of the precipitate.

† *Ann. de Chim. et de Phys.*, [v.], viii., p. 384.

NOTE ON STEEL PLATES.

By SERGIUS KERN, M.E., St. Petersburg.

The author had an opportunity of making some experiments respecting thick steel plates, rolled out of Bessemer mild steel. The ingots before rolling were hammered; the specimens selected from the plates were crossway samples. The results show the great advantage of annealing the plates, as the author's opinion is, that in plates prepared out of ingot steel it is preferable to have a high elongation, the strength being not less than 23 tons and not more than 27 tons per square inch, especially for boiler plates.

Hammered Ingots.

Carbon	0·155 per cent.
Manganese	0·450 ,,
Sulphur	0 020 ,,
Phosphorus	0·010 ,,
Silicon	0·025 ,,
Copper	none

The six rolled plates were tested unannealed and annealed.

I.—*Unannealed Plates.*

Length, 8"; breadth, 1·5".

Samples.		Ultimate Stress. Tons per Square Inch.	Elongation Per cent.
1.	1" thick	29·54	24·60
2.		29·63	23·50
3.		28·00	20·00
4.	$\frac{7}{8}$" thick	31·36	18·80
5.		26·80	21·30
6.		30·00	20·50

II.—*Annealed Plates.*

Length, 8"; breadth, 1·5".

Samples.		Ultimate Stress. Tons per Square Inch.	Elongation Per cent.
1.	1" thick	25·53	31·50
2.		25·27	29·25
3.		24·54	30·50
4.	$\frac{7}{8}$" thick	26·04	30·25
5.		23·89	31·50
6.		24·16	32·00

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Ordinary Meeting, April 10, 1880.

Prof. FULLER in the Chair.

NEW Members:—Mr. W. O. Smith, Prof. Judd, F.R.S.

A paper on the "*Human Eye as an Automatic Photometer*," by Mr. WILLIAM ACKROYD, F.I.C., was read. It is difficult to get the value of a very intense light in terms of a weak one, because the relative physiological values of the similarly coloured constituents are unknown. The author's experiments were made to show that the eye itself is a fairly good light measurer. When a "spot" or star of light is looked at from a distance, it is seen to emit "rays" or spokes of light at all angles. These are due to the radiate structure of the crystalline lens and the lachrymal fluid on the surface of the cornea of the eye. The rays are of various lengths; and are shorter in the first and second quadrants, next the nose or near the blind spots, than on the third and fourth quadrants, a fact probably due to the insensibility of this region. The iris expands and contracts under the stimulus of light independently of the will, and both irises act sympathetically. Now, the iris lies between the seats of irregular refraction, and thus any change in the size of the pupillary aperture will be rendered evident by an alteration in the length of the longer rays of a spot or point of light. On this fact is based the use of the eye as an automatic photometer. The sensitiveness of the iris varies in different persons. The author finds that a sperm candle burning 120 grms. per hour produces a distinct movement of his iris when 14 yards distant. In employing the eye as a photometer the author adopts the principle that if the light from one source, A, falling on the eye is capable of producing movement of the iris at a distance, *d*, and the light from a different source, B, is capable of producing the same movement at the distance *d'*, then the relative intensities can be found from the squares of these distances. To carry this out in practice the observer is in the dark, and an artificial star is placed on a level with the eyes at a fixed distance. Below this place the light to be tested in the same plane. While gazing steadily at the star the other light is to be eclipsed and revealed, and the observer is to find a position where the revealing of the second light does not influence his iris, as shown by no apparent shortening of the rays of the star taking place. He then approaches gradually till a second position is reached, where the revealing of the second light *does* produce a movement of the iris. The distance between this position and the light, *d*, is measured. A third light is now put in place of the second, and the same observations repeated so as to get a second distance, *d'*. From these distances the relative intensities are calculated. The author's results agree pretty closely with those of Rumford's photometer; but he found that for some reason the first two observations have to be discarded as too inaccurate. Owing to the sympathy between the two irises these experiments were binocular. This sympathy may prove convenient in constructing an eye-photometer, since one eye can be turned to the light to be estimated, while the other is looking at the artificial star. This method of photometry would be too delicate for comparing powerful electric lights unless aided by mechanical means, which, however, the author hopes to supply.

Prof. AYRTON then offered an explanation of the experiment shown by Prof. Guthrie at last meeting to the effect that while flannel rubbed with ebonite was + electrified, and ebonite rubbed with glass was +, flannel rubbed with glass was −. Prof. Ayrton accounted for this apparent anomaly on the grounds that one or more of the substances was an electrolyte. Glass, for instance, is an electrolyte, and a battery had been made from it. Experiments made by Prof. Perry and himself had shown that in a "pile" made up of divers substances, one or more of which were electrolytes, though the rest were metals, the electromotive force of the pile was equivalent to the algebraical sum of the several "pairs" composing it; but it was not equivalent to the electromotive force of the first and final plates made into a pair. That could not be predicted from the contact electromotive forces of the elementary pairs. When only metals were employed it could, but not in cases where an electrolyte entered. This same result would apply to Prof. Guthrie's frictional experiments. In answer to Prof. Guthrie's question whether electrolysis did not come into play in Prof. Ayrton's experiments, Prof. Ayrton replied that it could not operate to a greater extent than in Prof. Guthrie's experiments, as he had used a quadrant electrometer.

Dr. STONE then described a new tonometer, devised by Prof. Rudolf König, which he had recently seen in Paris. It consisted of a clockwork working into a tuning-fork, which produced no less than 128 escapes per second. To this clockwork, originally invented by an assistant of M. Breguet, and exhibited at the Paris Exhibition of 1856, Prof. König has added a Helmholtz vibration microscope moved by the clock, and the fork whose vibration-number is to be measured is placed vertically in the focus of the microscope. The apparatus is very portable and no loading of the forks is required.

Prof. HUGHES observed that he had patented a vibrating regulator in 1856.

Dr. GUTHRIE then exhibited an electric machine, formed of a collodion disk rubbed with catsfur and giving negative sparks. The collodion, after a suggestion of Capt. Abney, was put on by giving a disk a coat of collodion, then a coat of india-rubber dissolved in benzol, then a coat of collodion again. Prof. Guthrie also showed that an iron cylinder revolving round its longer axis, and with a current flowing in a wire parallel to it, has power to deflect a magnetic needle.

Prof. AYRTON stated that he had found the mere rotation of an iron cylinder produce the deflection in question, and therefore thought the current was not required to produce the effect shown.

NEWCASTLE-UPON-TYNE CHEMICAL SOCIETY

General Meeting, February 26, 1880.

Mr. JOHN GLOVER in the Chair.

THE minutes of last meeting were read and confirmed.

Mr. W. Beer and Mr. T. T. Sill were elected members of the Society.

The names of Mr. W. B. Campbell and Mr. W. B. Jackson were read for the first time.

The CHAIRMAN—The next business is the discussion on Dr. Lunge's paper on the "Composition and Analysis of Weldon Mud." It is a most interesting paper, and reflects great credit on Dr. Lunge. We shall be glad to hear the remarks of any member on the subject.

Mr JOHN PATTINSON—Dr. Lunge has furnished us with a paper which possesses much interest for many of the members of this Society. I have nothing to say about the relative merits of Bunsen's iodometric process and the permanganate and bichromate processes of determining oxygen in manganese oxides, further than that all the processes are probably capable of yielding accurate results when the operator, by experience, has learnt the best methods of using each process. For my own part, having had most experience with the bicromate process, I have most confidence in results obtained by it, and prefer it to either of the other processes.

I must, however, take exception to Dr. Lunge's statement on page 346, that calcium chloride answers the same purpose as ferric or zinc chloride in causing the whole of the manganese in a solution to be precipitated as peroxide

when the solution is boiled with solution of bleaching powder. About a couple of years ago I was very anxious to supersede, by a volumetric method, the troublesome and incorrect gravimetric methods then in use, for determining the total manganese in ores and other substances, and one of the essential requisites of such a process was that I should obtain the whole of the manganese in a definite state of oxidation, preferably as the peroxide. At that time I made a great number of experiments for this purpose, using known quantities of very carefully prepared pure protosesquioxide of manganese (Mn_3O_4). Now I knew that many of the text-books state that a solution of bleaching-powder precipitates manganese from its solutions as MnO_2, and I of course tried this method very thoroughly; but I found that, treat the solutions as I would, there was invariably a deficiency of manganese indicated when calculating the amount of manganese from the amount of peroxide found in the precipitate. In most of these experiments there was considerable excess of calcium chloride present when the precipitation occurred—at least fifteen equivalents calcium chloride to one of manganese. On referring to my note-book, I find that the average percentage of manganese obtained as peroxide in 61 tests made in presence of this excess of calcium chloride was 97·9 per cent of the total manganese present, the highest result being 99·37 per cent and the lowest 96 per cent. These experiments were made with the solutions at various temperatures, from 60° to 212° F. Two precipitations made when the solutions were boiling indicated respectively 97·31 and 97·49 per cent of the manganese precipitated as peroxide. When, however, ferric chloride is present in about equal quantity with the amount of manganese chloride, and the other conditions fulfilled, which are fully described in my paper read before the Chemical Society (see *Journal of the Chemical Society*, vol. xxxv., page 365), then the whole of the manganese is invariably obtained as peroxide.

I find by a careful perusal of Dr. Lunge's paper that he has not even tried the method I have proposed. He says at page 346:—"But in our Weldon mud it is not even necessary to add the salts mentioned by Mr. Pattinson, for there is always quite a sufficient quantity of calcium chloride present to satisfy the requirements of the case; and *we may assume from the outset* that Mr. Weldon's prescription as it stands will give perfectly correct results. I have therefore directed my experiments to this line; to find out how far the process could be simplified without taking away from its accuracy," He then describes some experiments with equal quantities of Weldon mud, which of course contained an unknown quantity of manganese, the results of which experiments show that the same amount of manganese was indicated under the circumstances described. Then, on page 347, Dr. Lunge says:—"Lastly, 5 c.c. was supersaturated with HCl, bleach liquor, water and calcium carbonate added, just as described by Mr. Pattinson. Result of two testings again: 8·4 c.c."—that is, the same result as the other experiments gave. Now, this is not the method which I have described as being essential to success. It is like playing "Hamlet" with the part of Hamlet omitted. The all-important part of the process is having a sufficient quantity of ferric chloride present when the precipitation takes place, and this Dr. Lunge has entirely omitted. Had Dr. Lunge tried a portion by the method I have described, I have no doubt he would have had a higher amount of manganese indicated than in his other experiments. Since Dr. Lunge's paper was read, to make assurance doubly sure, I have had the following three experiments made under the conditions I have found to give the best results:—

No. 1. With no calcium chloride present other than was in the bleach solution, and that formed by the action of the carbonate of lime on the chloride of manganese. No ferric chloride present.

No. 2. With 10 equivalents of calcium chloride in addition to the other calcium chloride, but no iron present.

No. 3. With 30 equivalents of calcium chloride in addition to the other, but no iron present.

No. 4. About 15 equivatents of calcium chloride present and one equivalent of iron as perchloride.

The following results were obtained:—

No. 1.	98·49 per cent of the Mn obtained as MnO_2.		
No. 2.	99·04	do.	do.	do.
No. 3.	99·04	do.	do.	do.
No. 4.	99·95	do.	do.	do.

Thus showing, although a very large excess of calcium chloride is present, yet that, unless ferric chloride is also present, the whole of the manganese is not obtained as MnO_2.

I quite admit that for manufacturing purposes the tests obtained without the addition of ferric or zinc chloride may be sufficiently exact; but this is certainly not the case for tests which have to decide the value of cargoes of say 1000 tons of ore, in which the difference of half a per cent in the manganese will make a difference of about £40 in price to be paid and received.

I think I have given abundant evidence to show that I am justified in coming to the conclusion that Dr. Lunge is wrong in assuming that chloride of calcium plays the part of ferric and zinc chloride in determining the precipitation of all manganese as peroxide under the circumstances described, and that the method he describes for determining total manganese in Weldon mud does not indicate the whole of the manganese.

I may mention here that I do not recommend the use of zinc chloride or zinc oxide in the place of ferric chloride and calcium carbonate when bichromate solution is used to titrate the remaining ferrous salt, for I find that the zinc very seriously interferes with the distinctness of the end reaction with solution of red prussiate of potash.

Mr. LAIDLER—I have also made a number of experiments to ascertain the effect of chloride of calcium in determining manganese by precipitating as peroxide with solution of bleaching-powder, and always found that the manganese was never precipitated entirely in the form of peroxide; but when ferric chloride is present when the precipitation takes place the results are always accurate, being never more than one or two hundredths of a per cent above or below the 100 parts.

On page 343, Dr. Lunge, in experimenting with Volhard's process, obtained from 5 c.c. of mud, with the addition of 2 grms. $ZnSO_4$, 0·1757 grm. of manganese, and from the same quantity of mud without zinc 0·1765 grm. manganese. Now, if the latter experiment is correct, as Dr. Lunge proves, he has obtained 0·5 per cent more manganese without zinc than with it, which, I think, is quite contrary to the experience of other experimenters. From this it seems to me that the method of measuring the mud by means of a pipette is not sufficiently accurate to decide the question as to the part played by zinc, and I think some better method of obtaining two identical quantities of such a substance as Weldon mud should have been resorted to than measuring with a small 5 c.c. pipette.

I should also like to ask if any member has tried Mr. Pattinson's process in its entirety in the estimation of the total manganese in Weldon mud; and if so, what were the results obtained as compared with the usual method of testing?

Mr. GLENDINNING—Since last meeting my attention has been drawn to the influence of $CaCl_2$ on thick batches. I caused three batches to be worked containing respectively 2, 1·9, and 1·8 equivalents of $CaCl_2$ to 1 of $MnCl_2$. The first two gave very good results, both as to manganese recovered and the quantity of base. The third gave a batch inclined to be thick. Those experienced in the matter know that when the slaty appearance, which is indicative of thickness, first makes its appearance, a very little addition of $MnCl_2$ is sufficient to cure it. So far as these results go, deficiency of $CaCl_2$ seems to be in some measure the cause of thick batches; and this is supported by the fact that such batches are frequently obtained at

the commencement of a Weldon process, and also when liquor from extra well-settled mud is used, in both of which cases the proportion of $CaCl_2$ to $MnCl_2$ will be low as compared with ordinary liquors.

An opinion which is pretty generally held is that excess of lime is the cause of thick batches, but analysis has shown that the quantity of lime is not necessarily excessive in such cases.

Dr. Lunge has advised the use of less heat as a means of avoiding thick batches; but as the most obvious action of $CaCl_2$ in the process is its solvent action upon lime, and as a high rather than a low temperature favours this action, therefore working at low temperature apppears to be tantamount to working with a less proportion of $CaCl_2$.

Dr. Affleck—I have no experience with Weldon mud myself, but should like to ask whether any members agree with Dr. Lunge's opponent in considering Weldon mud to be a mere mixture and not a chemical compound?

Mr. Glendinning—I have a full analysis of the mud, made at a very early period of the history of the process, so that it compares very unfavourably with the batches at present made, but it will show the very small amount of lime present in the mud:—

MnO	0·405	equivalents.
CaO	0·282	,,
MgO	0·329	,,
$CaCO_3$	0·063	,,
Fe_2O_3	0·033	,,
Al_2O_3	0·044	,,
Base	1·156	,,

The Chairman—Do you infer, then, that the mud is a mixture?

Mr. Stuart—Mr. Weldon holds the opinion that the mud is an unquestionable salt—is an acid manganite of calcium consisting of one equivalent of CaO combined with two equivalents of MnO_2, and in which the base is 0·5. The proportion of $CaCl_2$ to $MnCl_2$, mentioned by Dr. Lunge, is, I confess, new to me, but well worthy of further investigation.

Mr. Glendinning—In our ordinary working the proportion of $CaCl_2$ is much about the same; perhaps rather less.

Mr. Pattinson—I have not studied the question of the nature of Weldon mud very closely, but it may be interesting to point out that MnO_2 has a very strong tendency to carry down with it very considerable quantities of bases from solution. In making experiments on the estimation of total manganese I found it carry down almost every base, particularly baryta and potash; and Wright and Luff point out that considerable quantities of potash are taken down with MnO_2 on reducing $KMnO_4$ with alcohol.

Mr. Stuart—Mr. Weldon has clearly demonstrated the fact that hydrated MnO_2 combines easily with all the alkalies and alkaline earths to form salts with these bases.

Dr. Affleck—Has any one tried precipitating manganese liquors with caustic soda, and does the same excess require to be used as in the case of lime?

Mr. Stuart—Mr. Weldon has tried it and finds it very suitable. An equivalent is used to precipitate, and then the same excess is used as of lime to secure peroxidation.

Dr. Affleck—If the mud is a definite compound we should expect the same amount of soda to be required as of lime; but if a mixture, and if oxidation takes place simply when the solution is sufficiently alkaline, it ought to require a larger excess of lime than of caustic soda.

The Chairman—Probably Mr. Weldon will take up this point next month. I am sure we have had a most interesting discussion.

A Method of Producing Acetal.—MM. Engel and de Girard.—The authors obtain acetal in considerable proportions by passing a current of phosphuretted hydrogen into a cold mixture of alcohol and aldehyd.—*Comptes Rnedus.*

CORRESPONDENCE.

COMPOSITION OF "WELDON MUD."

To the Editor of the Chemical News.

Sir,—As the session of the Newcastle-upon-Tyne Chemical Society is now over, I beg to trouble you with a few remarks concerning the discussion of my paper on Weldon mud, read before that Society.

The reason why I assumed from the outset that Mr. Weldon's prescription for estimating the total manganese as it stands, yields correct results, was that there is a very large excess of calcium chloride present. Whilst Mr. Pattinson recommends ferric chloride, and Kessler zinc chloride, Volhard has proved that calcium or barium salts equally prevent the precipitation of MnO along with MnO_2.

I had, on repeating Volhard's process, found that the calcium chloride present in Weldon mud is sufficient for the same purpose, so that the addition of zinc salt to the solution makes no difference in the result of the test. It is true that in Volhard's and Pattinson's methods the precipitation of MnO_2 does not take place in the same way, viz., by potassium permanganate in the former, by bleaching-powder in the latter; but as there exists hitherto only one explanation for the formation of MnO along with MnO_2 in those cases, viz., the acid properties of MnO_2, I assumed, perhaps too rashly, that calcium chloride would have the same effect in Pattinson's as it has in Volhard's test. Now, Mr. Pattinson adduces experiments according to which, even with an excess of calcium chloride, 0·9 per cent Mn less is obtained than by adding ferric chloride. Probably a larger number of experiments would be desirable to settle this point definitely, but I do not mean to go into it at all, at least just now, for even taking it for granted I should say that it is of little consequence for my present purpose. An uncertainty as to one hundredth part of the amount of manganese may be of importance in a 1000 ton cargo of iron ore, as exemplified by Mr. Pattinson; but not in the case to which *alone* my paper referred, viz., the testing of Weldon mud. Here it is, in the first instance, quite sufficient to know the percentage of Mn to 1 per cent of the total, and, secondly, the only practicable method of taking the samples, viz., by means of a pipette, does not in itself admit of absolute accuracy, so that analytical processes of extreme refinement are out of place here.

Dr. Affleck has quite erroneously attributed to me the opinion that Weldon mud is a mere mixture, and not a chemical compound. This is the opinion of Dr. Post, from which I most decidedly *dissent*. In the present state of our knowledge I consider the acid properties of manganese peroxide fully proved, although I think it likely that its formula may not be simply MnO_2, but a polymer of this; from those acid properties I cannot but conclude that in Weldon mud there must be basic oxides in chemical combination, not merely in mechanical mixture, with manganese peroxide.—I am, &c.,

George Lunge.

Zürich, March 29, 1880.

THE DIRECT METHOD FOR TESTING VITRIOL CHAMBER EXITS.

To the Editor of the Chemical News.

Sir,—In my letter (see Chemical News, vol. xli., p. 70) I confined myself to stating facts. Mr. Vasey (p. 92) replied, not by a fair argument, but by an insinuation to the effect that my work was "incorrect" and "unreliable." On p. 145, Mr. Vasey admits the truth of the statements made in my letter, as will be seen by comparison, but he does not withdraw the insinuation. I therefore reply to his letter (p. 92) as follows:—

(1.) That the opinion which he says I copied from him was not his originally.
(2.) That I was present at the meeting of the Faraday Club in January, 1879, and I did hear Mr. Davis read the paper referred to.
(3.) That I was too busy with other reforms when I became manager here to attend to introducing the nitrometer test.

—I am, &c.,

W. Jessé Lovett.

Victoria Chemical Works, Bradford, Manchester, April 8, 1880.

PEROXIDE OF HYDROGEN AND OZONE.

To the Editor of the Chemical News.

Sir,—In a letter (Chemical News, vol. xxxviii., p. 243) addressed to you some time ago, upon the subject of a paper by Mr. Albert R. Leeds, which had appeared the week before in your excellent journal, I wrote as follows:—"The author seems to have fallen into an error committed by many other observers, namely, that of estimating as ozone everything in the atmosphere capable of colouring so-called ozonoscopic papers."

After a silence of more than twelve months Mr. Leeds has, in your last issue, taken me to task for this "unwarranted charge," and I shall feel obliged if you will now allow me to make an explanation. In his paper Mr. Leeds gave a long table, which was headed "Register of Ozone Observations made at Upper Saranac Lake," &c., and in one column, with the heading "Ozone," he gave the degrees registered at different places. No mention was made of peroxide of hydrogen in this part of the communication; and not having the remotest idea of what might follow, I ventured to call attention to what seemed to me to be a serious defect in the observations. Indeed I was anxious to point out the necessity of looking for peroxide of hydrogen in the atmosphere surrounding "hemlocks, pines, larches, and spruces." It is not to be denied that Mr. Leeds did, in a subsequent communication, show the ozonoscopes to be affected by this reagent, but still he did not use this further observation towards explaining the results in which I was specially interested; and on again reading his paper I cannot resist the impression that the table in question was intended, generally, to set forth the amount of ozone in the atmosphere at different places.

As for misquoting Mr. Leeds, I made neither quotation nor misquotation, as will be seen on referring to my letter. Mr. Leeds may rest assured that I entertain the most lively appreciation of his investigations, which are cited in more than one place in my new work entitled "Nature's Hygiene."

To proceed now to another matter mentioned by Mr. Leeds. If we exclude, for the time being, the oxidation of phosphorus, I must confess that I am not aware of any known process of slow oxidation which has been established to produce ozone, contravene as this confession may "the statements of those who have experimentally investigated the subject during the past forty years." But whose investigations, and what slow oxidations, would Mr. Leeds have me bear in mind?

It is quite true that, in my further critical note (Chemical News, vol. xl., p. 96), as Mr. Leeds says, I adduced "no new and crucial experiments," but at the same time I was able to refer to some such experiments previously published by me, and I have made a considerable number of other experiments which I do not intend to publish, because in their incompleteness they resemble some which have been published by others.

As regards, however, the oxidation of phosphorus, I have had some special apparatus made for studying this process, and hope shortly to be able to say something more certain about it and its results.

Although I have raised doubts as to the formation of ozone during the oxidation of phosphorus, I shall be quite prepared to believe that ozone is formed should the necessary evidence be forthcoming, but in the meantime I cannot attach much chemical weight to so imponderable a thing as an odour.

The other day I made the first experiment with my new apparatus, in which a quantity of phosphorus was submitted to atmospheric oxidation in five successive vessels. The gas was washed, and then passed into acidified iodide of potassium. The iodine liberated during a certain time required 0·8 c.c. of a decinormal solution of sodic thiosulphate, while the water in which the phosphorus was half submerged liberated iodine equal to 2·2 c.c. of the same thiosulphate solution.

As for Lamont's theory regarding the assumed formation of ozone, it is faulty in not explaining the necessity of the presence of water during the oxidation of phosphorus.

Finally, it will be seen that Mr. Leeds confirms a statement often made by me, viz., that it is very difficult to remove, by washing, peroxide of hydrogen suspended in an aërial current.

After all, the subject merely calls for more experiments, which in their turn demand time and resources, and while I hope that both Mr. Leeds and Prof. McLeod can command more of these things than I can, I will do my best in the matter.—I am, &c.,

C. T. Kingzett.

12, Auriol Road, West Kensington, W.

EDISON'S ELECTRIC LIGHT.

To the Editor of the Chemical News.

Sir,—As I judge from your last letter that you would be interested in the information, I will give you the result of some measurements recently made by Prof. A. M. Mayer, Ph.D., Mr. B. F. Thomas, Ph.D., and myself, on one of Edison's new carbon lamps. The lamp in question was kindly loaned to Prof. Mayer by Mr. E. A. Beach, Editor of the *Scientific American*.

We found, in the first place, that the electrical resistance of the carbon loop or "horse-shoe" rapidly decreased at high temperatures, so that while it was equal to 123 ohms at the ordinary temperature, it fell to about 76 ohms when so hot that the lamp gave a light of about 15 candles. Using a battery of 50 Bunsen cells as a source of current, and placing a "copper voltameter" (*i.e.*, plates of copper in concentrated solution of cupric sulphate), a galvanometer, and the lamp in the same circuit, we were enabled readily to measure the actual current when the lamp was giving a light of 15 candles. This was almost 1 volt., or exactly 0·905 of a volt. Such a current through a resistance of 76 ohms would of course convert therein, into heat and light, an amount of energy which, expressed in foot-pounds, would be about 2750 ft.-lbs. In other words, about one-twelfth of a horse-power. Twelve such lights could therefore theoretically be operated by one horse-power of energy in the shape of an electric current. In other words, with such a lamp the theoretical maximum of conversion into light is 12 burners of 15 candles each, or 180 candles per horse-power of *energy in the electric current*.

With the best form of dynamo-electric machine and "arc" lamp which I have tried in my Light House Board experiments I have obtained 1800 candles per horse-power of *mechanical force* applied to the driving-pulley of the machine. The *theoretical maximum* of Mr. Edison's lamp is thus ten times less than the *practical efficiency* of the arc light.

These results agree entirely with those obtained by Profs. Barker, Rowland, Young, and Brackett, who, as I see from to-day's papers, have been making similar measurements for Mr. Edison, at Menlo Park. Mr. Edison's lamp, therefore, like all previous efforts to employ incan-

descent conductors, involves an enormous loss of energy as compared with the arc light.

The numerous other questions bearing upon its commercial value I will not allude to here.—I am, &c.,

Henry Morton.

Stevens Institute of Technology,
Hoboken, New Jersey,
March 25, 1880.

ALKALIMETRIC DETERMINATION OF SULPHATES.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xli., p. 158, Mr. Otto Hehner points out that the method for the alkalimetric determination of sulphates which I published on p. 114 of the same paper is not new, but has been originally proposed by M. F. Jean. Mr. Hehner says: "It would surely be a simple matter to look over the indices of a few volumes of the Chemical News, or of any other chemical ournal, before describing and publishing methods as new." I fully admit the truth of this sentence, and am sorry that in trusting too much to my memory with regard to the analytical literature of the last few years I overlooked M. Jean's and M. Haubst's papers. But whilst giving M. Jean every credit due to him for having first published the principle of the method, I must insist on claiming that the details of my paper are entirely my own, and differ widely from Jean's details. In his original paper (*Comptes Rendus*, 83), Jean says: "I have assured myself that on working with sufficiently dilute solutions (*solutions peu concentrées*) and under the conditions indicated above, the alkaline carbonates do not decompose the sulphate of baryta." I have in vain looked in that paper for the "conditions indicated above," neither have I been able to find out what solutions M. Jean considers to be "sufficiently dilute." In that paper, nearly the whole of which, by the way, is given in the extract in the Chemical News (vol. xxxiv., p. 272), there is not one figure of analytical results given. In my paper I have worked out the method for one dilution and given the results which I found. The dilution is such as will occur most frequently in technical work. In that dilution I have found that sodium carbonate does sometimes decompose barium sulphate. Without having any knowledge of M. Jean's paper, I naturally tried a plan similar to his when I started my experiments, it being the shortest way, and I had to give it up as I found it not to be trustworthy.

In a paper published in conjunction with M. Pellet (*Bull. Soc. Chim.*, vol. xxvii.), and dealing with the analyses of the most important sulphates and their mixtures, all the analytical data that M. Jean gives are two analyses, not of mixtures, but of sulphates by themselves. Though one of these results, in which he used 0·112 gr. and found 0·110 gr. of potassium sulphate, is 1·8 per cent too low, he says:—"This method gives very exact results (*des résultats très-exacts*). A reaction, however simple, comprising the analysis of so many substances requires more than two analytical data to be established as a method, and M. Jean can hardly claim more than having proposed the principle of the method.

M. Jean mentions nothing of impurities in baryta, and yet it is well known to every chemist that it is impossible to buy pure baryta and very difficult to prepare it. The use of the method in technical laboratories, where one cannot always prepare one's own pure chemicals, is out of the question unless chemists are enabled to work with impure material such as they can purchase. I have shown in my paper how to do this, and also how to do away with the washing of the precipitates. I think I have now shown clearly enough that even if I had known M. Jean's paper I should have published my paper the same as I did, only altering the title. After the sentence quoted above from Mr. Hehner's letter, that gentleman goes on to say:—"Much time might thus be saved to reading chemists and confusion avoided." I cannot admit that this sentence has any bearing on my paper. If Mr. Hehner had taken the trouble to read my paper he would very likely have left out his general remarks, and his letter would be no worse for it.—I am, &c.,

J. Grossmann.

St. Helens, Lancashire,
April 10, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 11, March 15, 1880.

Reply to the Observations of M. Berthelot concerning Chloral Hydrate.—A. Wurtz.—M. Berthelot admits in his last paper that "everything leads us to believe that chloral hydrate is dissociated in part at 100°, and that the decomposition tends to become complete at 100°, and at a low pressure." This opinion approximating closely to what M. Wurtz has maintained, it is needless to prolong the discussion.

Action of Oxygenated Water upon Silver Oxide and upon Metallic Silver.—M. Berthelot.—When oxygenated water is brought in contact with silver oxide reduction takes place, but the volume of oxygen set free is merely equal to that present in the oxygenated water. The residual matter contains the whole, both of the silver and the oxygen originally present, but the distribution of these elements has been changed under the action of the hydrogen peroxide, so as to represent a mechanical mixture, in which one-third of the silver is free and the corresponding proportion of oxygen converts the residue of the silver oxide into sesquioxide.

On a Microphonic Apparatus receiving Words at a Distance.—MM. P. Bert and d'Arsonville.—The authors, in the course of their researches on deafness, have attempted to construct a micro-telephone, which should solve the following double problem:—On the one hand, strengthen the sound-vibrations of speech, which the telephone merely weakens, and on the other hand, collect these vibrations at the distance of several metres from the speaker. The latter portion of this task they consider as accomplished.

The Economical Yield of Electromotors, and the Measure of the Quantity of Energy which Traverses an Electric Circuit.—M. Marcel Deprez.—The quantity of energy is proportional to the product of the intensities of the two currents, or to the product of the deflections of the needles.

Application of the Telephone to the Measure of the Torsion of the Motor Shaft of Moving Machinery.—C. Resio.—The author proposes an arrangement for measuring the torsion of a moving shaft, and consequently the effort and the work transmitted to such shaft.

A Process for the Measurement of Elevated Temperatures.—J. M. Crafts and F. Meier.—This paper does not admit of useful abstraction.

Electrolysis of Malonic Acid.—E. Bourgoin.—In the free state this acid is very stable as regards the current, and becomes concentrated in the positive compartment—a double character, which distinguishes it from its lower homologue, oxalic acid. In a concentrated and alkaline solution it does not, in any case, give rise to a carbide of hydrogen, which distinguishes it from succinic acid. These differences are such that if free methylen had not hitherto escaped from all researches, we should be tempted to believe that synthetic malonic acid is not the true homologue of oxalic and succinic acids.

Synthesis of Ulmic Bodies.—A. Millot.—On passing an electric current into acidulated water, taking for the negative electrode a plate of platinum, and for the positive electrode a piece of gas-coke, the coke is quickly disaggregated and falls to the bottom as a powder. If an alkaline solution is substituted for the acid, the coke is still broken up, but a portion dissolves in the liquid, which takes an intense black colour. The author used an ammoniacal solution subjected to the action of a thermo-electric battery, about equal to two Bunsen elements. The black liquid obtained is precipitated by mineral acids, when a substance is produced analogous to the nitrogenous glucose described by M. Thenard. The precipitate is entirely soluble in water when the acid has been removed by washing, but after desiccation at 150° it no longer dissolves in water. It does not yield ammonia if boiled with concentrated potassa, but if heated with potassa it gives rise to potassic cyanide. The coke used had been purified by means of a current of coke at a red heat for thirty hours, a time more than sufficient for the removal of the hydrocarbons.

The Products of the Splitting up of Proteic Bodies.—M. Bleunard.—The author has formerly shown that the organic matter of stag's horn is decomposed by hydrate of baryta in a manner analogous to albumin, yielding, in addition to ammonia and carbonic and oxalic acids, an amidic mixture, answering approximately to the general formula $C_nH_{2n}N_2O_4$, the value of n being lower than in the amidic mixture from albumin. Further researches have shown that the chief part of the mixture consisted of a gluco-protein, answering to the formula $C_6H_{12}N_2O_4$.

Artificial Production of Felspars with Barytic, Strontic, and Plumbic Bases, Corresponding to Oligoclase, Labradorite, and Anorthite.—F. Fouqué and A. Lévy.—The authors describe the proportions of the ingredients and the procedures employed.

Examination of Volcanic Dust falling January 4, 1880, at Dominica.—M. Daubrée.—This dust is remarkable as containing a considerable proportion of iron pyrites and of galena.

Separation of Minerals heavier than Quartz by means of a Melted Mixture of Lead and Zinc Chlorides.—R. Bréon.—The specific gravity of liquid lead chloride is 5, and that of zinc chloride 2·4. By mixing these two bodies in variable proportions, liquids may be formed ranging between these two limits, in which certain portions of a mineral powder will sink, whilst others float on the surface.

Composition of the Mineral Waters of Bussang (Vosges).—E. Willm.—These waters contain iron, manganese, and arsenic, and calcium phosphate, borate, and fluoride.

Chemiker Zeitung.
No. 6.

Determination of Sulphur in Pyrites.—G. Lunge.—The author maintains that his process, though yielding results less absolutely accurate than those obtained by the method of Fresenius, is yet preferable for use in chemical works where time is the first object. He thinks that the larger proportion of sulphur obtained by the process of Fresenius is partly due to the fact, that both galena and heavy spar,—bodies frequently found in pyrites—are attacked by the dry process.

Determination of Manganese and Cobalt.—C. Rössler.—The cobaltous salt is mixed with a measured quantity of a silver solution of known strength, the liquid is heated on the water-bath and precipitated with potassa lye (not with sodium carbonate). There is formed a deep black precipitate of the composition $Ag_4OCo_2O_3$. In other respects the process is conducted as for manganese. If nickel is simultaneously present, the results are too low. More accurate results are obtained, if from the nitric solution of the two metals the cobalt is first separated by means of potassium nitrite; the precipitate, filtered off without washing, is then re-dissolved in nitric acid, and the cobalt is determined volumetrically.

Experimental Researches on Infection with Town Sewage and Water from Manufactories.—Dr. R. Emmerich.—Acid, recently voided urine is, according to the author, harmless as water, and there is hence no occasion to forbid its discharge into large rivers. As urine in a few days after emission becomes intensely poisonous, its retention in the vicinity of human habitations and its infiltration into the subsoil of towns should be pronounced dangerous. Human solid excrement immediately after its discharge produced deadly effects if suspended in water and injected subcutaneously. But if diluted with 20,000 parts of water, it can be injected even to the extent of 60 c.c. without occasioning injury. Hence water containing excrement in such proportions may be used for drinking! [How if choleraic or typhoid germs are present? *Ed.* C. N.] Into rapid streams, where the dilution must be at least 100,000-fold, sewage may be discharged without hesitation.—*Bayr. Akad. d. Wissenschaft.*

Annalen der Physik und Chemie.
Heft 3, No. 11, 1879.

The Law of Stokes.—E. Hagenbach.—After a prolonged investigation the author concludes that at present there exists no reason for rejecting the law of Stokes, and that Lommel's classification of fluorescent bodies is not founded upon any essential difference in their behaviour.

Experimental Researches for Determining the Index of Refraction of Liquefied Gases.—L. Bleekrode.—The author's results are given in the form of tables.

The True Theory of Fresnel's Interference-Phenomena.—H. F. Weber.—Fresnel asserted that observation and measurement confirmed all the deductions which he drew from his theory. This agreement between theory and fact does not exist; a close examination of Fresnel's interferences makes it manifest that not one of his theoretical deductions agrees with the phenomena. It is therefore to be wished that all researches which have been based upon this theory, *e.g.*, the experiments of Töpler and Boltzmann on the vibrations of the air, might undergo a revision.

Influence of Temperature upon Tuning-Forks.—H. Kayser.—The author's results are as follows:—(1.) The number of vibrations of a tuning-fork is not unaffected by the temperature, of which, between 0° and 30°, it is a lineal function. (2.) The influence of the temperature is greater the higher the tone of the fork. (3.) In moderate changes of temperature, such as may occur in a dwelling room, the number of vibrations is affected in the second decimal place. (4.) The coefficient of elasticity of steel increases with the temperature between 0° and 30°.

The Galvanic Conductivity of Metallic Alloys.—Emil Elsässer.—The author enumerates a series of alloys which conduct without undergoing decomposition. From these composite conductors to the electrolytes the transition is gradual, and between the two groups are substances which conduct at low temperatures without decomposition, but undergo electrolysis at higher temperatures, and in part even before they are melted. A third class of bodies have not undergone electrolysis because they are too infusible, and a fourth class of compound bodies conduct neither with nor without decomposition. It would be important to determine for each element with which of its combinations electrolytic conductivity begins.

Electric Perforation of Glass.—E. Mach and S. Doubrava.—The authors found an explanation of Prof. von Waltenhofen's experiment on the fact that the glass surface in comparison with a stearin surface must be regarded as conductive.

Electric Perforation of Glass.—A. von Waltenhofen.—This paper requires the accompanying illustrations.

Movement of Plates between the Electrodes of the Holtz Machine.—S. Doubrava.—The author describes a number of experiments undertaken with a view to the explanation of the above-mentioned phenomena.

Relations between Galvanic Resistance and Specific Heat.—Felix Auerbach.—A mathematical paper, not susceptible of useful abstraction.

Currents of the Gramme Machine.—O. E. Meyer and F. Auerbach.—This memoir cannot be intelligibly abstracted without the accompanying illustrations.

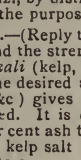
Description of Experiments undertaken with Electricity of High Tension by means of the Telephone.—L. Weber.—These experiments seem to support the assumption that the part played by an electrolyte in an induction circuit consists not alone in a condensing activity of the molecules, but in a real conductivity, which must be regarded either as electrolytic convection or as a purely galvanic process.

NOTES AND QUERIES.

Keeping Salts of Ammonia.—Can any of your numerous readers inform the writer whether large stocks of sulphate and muriate of ammonia lose weight by keeping in dry sheds for twelve or eighteen months? The opinion of parties who can speak from absolute experience is respectfully asked for.—H. J. BLAND.

Formic Acid.—I note in an article in the *Journal of Science* for April, page 227, that "it is found that if carbonic oxide . . . is passed over caustic soda and lime . . . formic acid is generated in such abundance that, if required, it would be available for industrial purposes." Can you inform me of any published account of the process referred to? If this acid could be produced at a sufficiently low price I could use large quantities of it. The cheapest means of making it hitherto known—viz., by distilling oxalic acid in presence of glycerin—is too costly for the purpose required.—F. G. L.

Valuation of Soda-Ash.—(Reply to "K").—The difference between the desired strength and the strength of the strong alkali gives *the quantity of the weak alkali* (kelp, salt, &c.) that must be used; and the difference between the desired strength and the strength of the weak alkali (kelp, salt, &c) gives *the proportionate quantity of strong alkali* that must be used. It is done at a glance. Thus, suppose we want to reduce 52 per cent ash to 48 per cent with 11 per cent kelp salt. This gives 4 parts kelp salt to 37 parts of the 52 per cent ash: practically, 1 shovelful to 9.



—F. E. V.

MEETINGS FOR THE WEEK

MONDAY, 19th.—Medical, 8.30.
—— Society of Arts, 8. Robert W. Edis, F.S.A., "The Decoration and Furniture of Town Houses."
TUESDAY, 20th.—Civil Engineers, 8.
—— Zoological, 8.30.
—— Pathological, 8.30.
—— Royal Institution, 3. Mr. R. H. Scott, 'Wind and Weather."
WEDNESDAY, 21st.—Society of Arts, 8. Mr. Holman Hunt, "The Present System of Obtaining Materials in use by Artist Painters, as Compared with that of the Old Masters."
—— Meteorological, 7. Discussion on Mr. W. Ellis's paper "On the Greenwich Sunshine Records 1876-80." G. M. Whipple, B. Sc., F.R.A.S., F.M.S., "On the Rate at which Barometric Changes Traverse the British Isles." J. W. Zambra, F.M.S., "A New Form of Six's Self-Registering Thermometer.'
THURSDAY, 22nd.—Royal Society Club, 6.30.
—— Royal, 8.30.
—— Zoological, 4.
—— Royal Institution, 3. Prof. Tyndall, "Light as a Mode of Motion: Theories of Light and Colour."
FRIDAY, 23rd.—Royal Institution, 8. Mr. W. H. Pollock, "Dumas Pere," 9.
—— Quekett, 8.
—— Clinical, 8.
SATURDAY, 24th.—Royal Institution, 3. Mr. James Sully, "Art and Vision."
—— Physical, 3.

TO CORRESPONDENTS.

G. D. R.—Bunsen's "Gasometry" is one of the best works you can consult.

THE JOURNAL OF SCIENCE

for April (Price 1s. 6d.), includes—

Our Friends and how we Treat them.
Organic Synthesis and its Social Bearings.
Instinct and Mind. By S. Billing.
Modern Advances in Meteorology
The Rate of Animal Development. By J. W. Slater.
On Water and Air. By Prof. Tyndall, D.C.L., LL.D., F.R.S. (Lecture IV.) Illustrated.
Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

THE MIDDLESEX HOSPITAL MEDICAL SCHOOL.

SUMMER SESSION, 1880.

LECTURES and CLINICAL INSTRUCTION in the Wards will commence on MAY 3rd. Gentlemen can enter to any one Course or to Hospital Practice only. Two Entrance Scholarships of the annual value of £25 and £20 respectively will be offered for competition at the beginning of the Winter Session. The Broderip and Murray Scholarships are competed for by Students who have completed their Third Winter Session.

For prospectuses containing particulars as to Resident Appointments, Fees, &c., apply to the Dean or the Resident Medical Officer at the Hospital.

ANDREW CLARK, Dean.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 14 Berners-street W.

ORGANIC MATERIA MEDICA.

By DR. MUTER.

Analytical Chemists will find this a concise and yet complete book of reference for the isolation and examination of the active principles of drugs. Special appendix on the microscopic characters of the starches in food and drugs. Copious index and qualitative courses or resins, &c.

Published by W. BAXTER at the Office of the South London School of Pharmacy, Kennington Cross, S.E., and sold by Messrs. Simpkin and Marshall and Messrs. Baillière, Tindal, and Cox.

WILLIAM AND WILLIAM T. FIELD,

MANUFACTURERS of the Celebrated STAFFORDSHIRE BLUE BRICKS, specially adapted for Chemical Plant, *i.e.*, Acid Towers, &c. Also all other kinds of Best Staffordshire Blue Bricks, Pavings, Plynths, Splays, Copings, &c. &c. Prices and samples on Application.

TESTIMONIAL.

"We have used the Blue Staffordshire Brick for Sulphuric Acid Towers, &c., manufactured by Messrs. Field, for the last fifteen years, during which time they have given great satisfaction. We recommend them to the Chemical Trade, believing there is nothing better in the market."—(Signed) WILLIAM HUNT and SONS, Lea Brook Alkali Works, near Wednesbury, Staffordshire, February, 1878.

TOLL END BRICK-WORKS,
TIPTON, STAFFORDSHIRE.

ROYAL POLYTECHNIC.—Lectures on

the Phenomena of Nature, illustrated by Dissolving Views and Experiments, by Mr. J. L. King. Arctic Exploration, its History and Prospects, by Mr. W. R. May. Balmain's Luminous Paint, or a Trap to Catch a Sunbeam. Wonderful New Automatic "Blondin," which will traverse the whole length of the Hall on a rope suspended thirty feet from the floor. Tableaux Vivants of events in the life of Mary Queen of Scots; the descriptive poem by Bell, read by Miss Alice Burnelle, the character of Mary impersonated by Miss Eva Russell. New Ghost Piece, written by Ellis Reynolds, entitled The Magician Foiled. Also, Leotard the Automaton, the Diving Bell the Electric Organ, Going Machinery, and many Novelties. Open from 10 till 1, 2 till 5, and 6 till 10; for times of Entertainments see daily papers. Admission, 1s. Reserved Seats, 2s., 1s., and 6d. extra

TOWNSON & MERCER,

89, Bishopsgate Street Within,
LONDON.

Wholesale and Export Dealers and Manufacturers of

CHEMICAL & SCIENTIFIC APPARATUS
PURE CHEMICALS, &c.,

For Analysis and the general Laboratory Use of Manufacturers and Professors of Universities, Schools, Mines, &c.

Now ready,
TOWNSON & MERCER'S COMPLETE CATALOGUE Chemical and Scientific Instruments, Pure Chemicals &c. Demy 8vo. Illustrated with upwards of 800 Woodcuts. Price 2s. 6d. post free.

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

JESSE FISHER & SON,
Phœnix Chemical Works Ironbridge.

JULIUS HÜLSEN & CO.,

NEWCASTLE-ON-TYNE,
AGENTS FOR THE BRAND (B.C.).

BLANC FIXE for Paper Enamelling Purposes; Dull and Bright Surface.

CHLORIDE OF BARIUM, Calcined, 95%, for Sugar Refining purposes, &c., &c.

MANUFACTURED AT THE
BLAYDON CHEMICAL WORKS,
BLAYDON-ON-TYNE.

SPECIALITIES.

MANGANESE Finest Crystallised, Lump, Ground, and Granulated of every quality, and PREPARED for *Chlorine*, *Glass*, *Steel*, *Ferro-Manganese Pottery*, *Battery*, and EVERY PURPOSE.

BAUXITE (Hydrate of Alumina) Of high percentage o Alumina and almost free from Iron. The CHEAPEST, BEST, and MOST PROFITABLE article from which to produce ALUM, ALUM CAKE, and SULPHATE OF ALUMINA, &c. [BRAND, "IRISH HILL BAUXITE."]

FLUOR-SPAR Of the Very Finest Quality for Acid, Soda, Glass Flu.., and all purposes.

BARYTES (Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

CRYOLITE, Magnesite, Felspar, Arsenic, Phosphates French Chalk, Strontia, Wolfram, Chrome, Terra Alba, Rotten Stone, China Clay, Umbers Ochres, Antimony, Calamine, Emery Stone all Oxides, and all

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,

MINE PROPRIETOR,
Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.
OFFICES—26 CHAPEL STREET, LIVERPOOL.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA.

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

GREENBANK ALKALI WORKS COMPANY
(LIMITED),
ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{2}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{1}{200}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

THOMAS ADKINS & CO.,
SMETHWICK
NEAR BIRMINGHAM

MANUFACTURERS OF SPECIALLY PREPARED RED LEAD FOR FLINT-GLASS MAKING.

CHEMICAL & PHYSICAL APPARATUS,
BOTTLES, PURE CHEMICALS,
REAGENTS, STANDARD SOLUTIONS,
And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

MOTTERSHEAD & CO.,
7, Exchange Street and 10, Half Moon Street,
MANCHESTER.

DAHL & CO.,
BARMEN (RHENISH PRUSSIA),
MANUFACTURERS OF
ANILINE AND NAPHTHALINE COLOURS.
SPECIALITY—Ponceau Naphthol-Reds as a Substitute for Cochineal.
Sole Agency and Depôt in England,
THEODOR BANG,
BENSON'S BUILDINGS, BASINGHALL ST., LEEDS.

THE CHEMICAL NEWS.

Vol. XLI. No. 1065.

A NEW BLOWPIPE TEST FOR PHOSPHORIC ACID.

By Lieut.-Colonel W. A. ROSS, late R.A.

Phosphorus, whether oxidised or not, is so nearly universally present in the organised world—and probably more than we imagine in the inorganic—that I will not apologise for now introducing this branch of the important subject of its detection and afterwards of its estimation, to the notice of your many readers. I am the more anxious to do this *at once*, as I wish to obtain the opinion of competent chemists regarding the reliability of this test before it appears in my work, "An Alphabetical Manual of Blowpipe Analysis," which Mr. Trübner has now in the press.

(1.) The test is based on the well-known property of pure tungstic acid to afford a brilliant *blue* bead in the "reducing flame" of the blowpipe with *phosphor*-salt, but only a yellow or brownish bead in "R.F." with borax: a fact first proved by Bergmann, in correction of some blowpipe experiments on Tungsten by its illustrious discoverer, Scheele. (*Vide* Scheele's "Chemical Essays," p. 294). In "Pyrology" (page 190) I have applied this test by using an acid medium, viz., boric acid; but I find that the test is far more delicate—in fact quite equal to one of the most delicate of known reactions, sodium manganate—by using instead, soda or potash.

(2.) Tungsten or Wolfram—as all chemists, pyrological or "wet," know—"forms three oxides, WO_2, WO_3, and W_2O_5, neither of which exhibits basic properties." ("Fownes," page 507). As far as blowpipe operations are concerned, the trioxide forms *yellow* or colourless solutions, as in borax in the "oxidising flame": the dioxide is very dark brown or *black*—it appears floating as insoluble black fragments in boric acid; and the curious intermediate oxide, which I assert to be such an excellent detector of phosphoric acid,* gives a *fine blue* colour to microcosmic salt, "R.F."

(3.) Your readers will doubtless see now, that the basis of the reasoning employed by me is that, commencing to operate with the WO_3, even the "reducing flame" of the blowpipe is unable to reduce the yellow trioxide of tungsten below the blue intermediate oxide, when it is dissolved in such a highly oxidised and oxidising reagent as phosphoric acid; and it is this fact which makes the latter such an excellent detective of tungsten in presence of all the soda of microcosmic salt. I have, therefore, by this test, simply ascertained that even such a reducing agent as potash or soda, is, before the blowpipe, unable to keep contained tungsten below the blue or intermediate condition of oxidation when traces of free phosphoric acid are present, and the alkaline bead is placed in the position I have termed "the peroxidising pyrocone," or P.P.

(4.) By this delicate test it seems possible to prove (what I have for years suspected) that it is the presence of phosphoric acid in extremely minute proportion which causes hydrated silicic acid to opalesce (just as a trace of it causes the analogous boric acid to opalesce), and to form the gem called the *Opal*.

(5.) A bead of pure potassium carbonate is first fused upon platinum wire, and as much powdered "rock-crystal" or pure silica treated on it before the blowpipe as will form a *clear* bead of potash glass. A small fragment or bead of potassium pyrotungstate (made by fusing pure tungstic acid with pure potash on aluminium plate until all effervescence has ceased) is now taken up on the glass bead and treated in P.P. If the silica was pure, and all carbonic acid has been eliminated from the potash, there will be no decided colour, but the combined bead will remain a dull greenish grey colour.

(6.) Instead of taking up "rock-crystal," powdered *opal* is now combined with the potash bead and treated as in (5), when a *brilliant greenish blue* (turquoise) colour results, which can be made more blue by adding potash.

(7.) In the case of phosphates, such as *coprolite* or *kunkur*, the powdered assay is first dissolved in a bead of boric acid by cautiously adding traces of potash, which forms sufficient potassium borate to dissolve the lime, &c., leaving the phosphoric acid *free*, when I cannot but believe that some analogous combination to the well-known $12WO_3K_8Si_4O_6$ is formed, which is *blue*.

(8.) An authority on the blowpipe has written to me that he believed the blue colour to be due to a trace of manganese contained as an impurity in the tungstic acid from which my potassium tungstate was made, but he is, I believe, now convinced that he was wrong in that supposition.

* It will also detect traces of boric acid *under certain conditions*, which must provide against the formation of alkaline borates; *e.g.*, the use of pure silica as a medium.

EDIBLE EARTH FROM JAPAN.

By E. G. LOVE, Ph.D.,
Gas Examiner for the City of New York.

Among the many questions which present themselves in studying the customs of semi-civilised peoples, none is more interesting than that of the prevalent and deeply-rooted custom of earth eating: nor is this custom easily accounted for. Alex. von Humboldt attributed it to the "desire to fill the stomach, and thus in a measure to allay the pangs of hunger." Prof. Fuchs thinks a more satisfactory explanation is to be found in the fact that the eating of the unctuous mass obtained by moistening these earths with water produces sensations similar to those felt in eating any fatty substance. A very natural theory would be that it was eaten for its nutritious effect, but analyses show hardly more than 1 per cent of anything approaching nutritious matter. It is also noticeable that in many countries where this custom exists there is no scarcity of other and nutritious food. Sometimes it is eaten because ignorantly supposed to contain certain beneficial properties. However completely these theories may explain this strange custom, there seems to be sufficient ground for the belief that among the more uncivilised, in times of great want, the people were compelled to eat earth to partially allay hunger, that in this way a disease was formed from which it was difficult to free themselves when food again became abundant. Among certain negro tribes there can be no doubt as to the existence of such a disease—a disease of the nutritive functions. Other more civilised peoples may have commenced eating earth for some superstitious reasons or for some pleasurable sensations produced, and ultimately the disease became established. In all cases, however, the existence of the disease seems necessary to explain the custom.

That the Japanese people, in part even, should be addicted to earth eating will surprise many who know the resources at the command of this people, and the little necessity they have for eating earth. Some time ago I had placed in my hands a specimen of edible earth from Tsietonai, on the north coast of Yesso, and used by the Ainos as food. The meaning of the word Tsietonai (Eat-Earth Valley) has reference to this fact. The Ainos seem to think the earth contains some beneficial substances. It is by no means a necessity with them, for really they are a meat-eating people, having venison in abundance, and nature has also supplied them with much in the way of a vegetable diet.

The bed from which this specimen was obtained occurs in a small valley, and is several feet in thickness. It is of a light grey colour and very fine in structure. The following is an analysis:—

Silica	67·19
Alumina	13·61
Oxide of iron	1·11
Oxide of manganese	0·07
Lime	3·89
Magnesia	1·99
Potassa	0·23
Soda	0·75
Sulphuric acid	0·19
Phosphoric acid	trace
Water and volatile matter	11·02
	100·05

This analysis shows that the earth is essentially a silicate of alumina with silicic acid, and is similar in composition to those eaten by the Javanese and Laplanders. The "volatile matter," which was only small in amount, consists of the fragments of the leaf of some plant, which either the people intentionally mix with the clay for the aromatic principle it contains, or which was accidentally picked up when the specimen was taken. On treating this leaf with ether and evaporating, I obtained some oily matter of an agreeable odour, but too small in amount to enable me to determine its nature.

The Ainos eat this clay in the form of a soup. Several pounds are boiled with lily roots in a small quantity of water, and afterwards strained, and the soup thus prepared is claimed to be a very palatable dish.

New York, March 8, 1880.

A DIRECT METHOD OF TESTING VITRIOL EXITS FOR NITROGEN COMPOUNDS.*

By GEORGE E. DAVIS.

VITRIOL chamber exits, as you are aware, are usually tested by ascertaining the total acidity of the gases, expressed in grains per cubic foot. In some works it is usual to differentiate these acid gases, and to state the results in such a manner as to show how much of this acidity is due to nitrogen compounds and how much to those of sulphur. In order to make this test, the usual plan is take the total acidity of the solution through which a definite volume of the acid gases has been passed, and afterwards to precipitate and weigh the sulphuric acid as the barium salt. By this means the sulphuric acid is estimated directly, the nitrogen acids being determined by difference. You will therefore see that any error in the analytical operation is sure to be thrown upon the nitrogen compounds.

The method I am about to describe is a direct method; may be direct for the nitrogen compounds only, or for the three principal constituents of chamber-exit gases, the sulphur compounds, those of nitrogen, and the hydrochloric acid. The manipulation is simple, it is rapid and accurate, and the total acidity is a check upon the other figures.

I must first of all mention the very convenient continuous aspirator which I have been using, and may be of use to those who have not a good water-supply near to the chamber-exit. It consists of a 10-litre glass bottle with two tubulatures, one at the top and the other at the side near the bottom. Into the bottom tubulature is fitted a cork, into which is inserted a tube for the outflow of water, and regulated by a screw pinckcock. The top tubulature is closed with a cork having a central perforation, a long tube passes down through the cork to nearly the bottom of the vessel, which by this means is converted into a Marriotte's bottle. When set at any definite speed of outflow the water will continue to run at one even rate until the bottle is nearly empty. I have had an aspirator of this kind working continuously without any attention for periods of thirty-six hours. Good clear water free from any suspended matter must be used with this form of continuous aspirator.

Whether or not this form of aspirator is used the test is made in the same way. A measured quantity of peroxide of hydrogen and the necessary volume of water is placed in the aspiration tubes, and a known volume of the exit-gases drawn through. The solution is then to be made up to a definite volume, and divided into three portions. One is titrated with pure normal sodium hydrate solution, and subsequently acidified, and the sulphuric acid precipitated with barium chloride. The second portion is warmed, treated with solution of potassium permanganate to decompose the peroxide of hydrogen, neutralised with carbonate of soda solution, and titrated for hydrochloric acid with decinormal silver nitrate in the usual way. The third portion is treated with a little silver sulphate, neutralised, filtered, and evaporated on the water-bath to about 1 c.c. When cooled a drop or two of sulphuric acid is to be added to decompose carbonates, and the solution is then transferred to Crum's nitrogen tube. Twice its volume of pure and concentrated sulphuric acid is now added, and the whole shaken up with the mercury; the evolved nitric oxide is allowed to cool, and measured.

10 c.c. of a 10 volume solution of peroxide of hydrogen will oxidise about 7 grains of sulphurous acid. The process may, perhaps, be better understood by an example:—Mr. Vasey has been good enough to aspirate for me 0·625 of a cubic foot of the gases from a vitriol exit by means of the aspirator I have just mentioned. The sample was taken between 12.30 p.m., Sept. 19, 1878, and 11 a.m., Sept. 20, 1878, or a continuous run of twenty-two and a half hours. When the sample was handed to me I made it up to 625 c.c., so that each 100 c.c. should be equivalent to one-tenth of a cubic foot of the exit-gases. 500 c.c. required 0·9 c.c. of normal soda solution, and gave 1·2 grains of sulphate of barium. 100 c.c. when treated in the nitrogen tube gave 0·8 c.c. of nitric oxide. The hydrochloric acid was found to be 0·04 grain per cubic foot. We have, then,—

Grains per cubic foot.

Carbonate of soda neutralised by S compounds	1·092
" " " " N "	0·282
" " " " HCl "	0·059
	1·433
Carbonate of soda actually neutralised	1·468

If the nitrogen compounds and the total acidity be all that is required the operations are very simple. The solution of the gases must be titrated with normal pure caustic soda, and then evaporated as above upon the water-bath to 1 or 2 c.c. The subsequent treatment is the same as before described.

The method of using peroxide of hydrogen only in the aspiration-tubes you will find much better than the plan I at first adopted of putting the peroxide to a known volume of caustic soda solution. In the latter case a much larger quantity of sodium sulphate is produced, which does not conduce to the easy working of the process.

Several members have raised objections to this process owing to the alleged instability of peroxide of hydrogen. It has been stated that the solution might be decomposed by simply drawing air through it. This might be the case in an alkaline solution, as simple shaking will liberate most of the oxygen; but in an acid solution peroxide of hydrogen is very stable, as may be inferred when I tell you that the sample Mr. Vasey collected still contained some undecomposed peroxide, though alkaline and a current of air had been bubbling through it for over twenty-

* Read before the Faraday Club, February 19, 1879.

two hours. If anyone will work the process with intelligence I am sure he will be satisfied with it.

In the discussion which ensued several members stated that they had tried an alkaline solution of peroxide of hydrogen with a continuous aspirator, and found that oxygen was liberated. Mr. Vasey gave as his opinion that the aspirator mentioned above was too small. He had to fill the bottle three times to get 0·625 foot, and the current of water was so slow that unless the water used was very clean and free from suspended matters the narrow water passage was easily stopped up.

THE VOLATILISING-POINT OF METALLIC ARSENIC.

By EWING G. M. CONECHY.

The statement of the temperature of volatilisation of metallic arsenic being given by different authors at temperatures varying from 180° C. to a dull red heat, and the true value being required for some work on which Mr. Hannay is engaged, I have determined it by using the melting-point of solids placed near the arsenic to indicate the temperature at which it gave a distinct sublimate. Dr. Carnelly's determinations of melting-points were used, and to prevent oxidation of the arsenic the experiments were conducted in an atmosphere of coal-gas.

I placed in a glass tube small quantities of metallic arsenic, argentic chloride, argentic phosphate, and zinc iodide, and heated gradually. When the arsenic had yielded a distinct sublimate, I removed the source of heat, and found that the zinc iodide had completely melted, while the argentic chloride had agglomerated and was on the point of melting. I therefore concluded that the arsenic did not volatilise below 446° C., which is the melting-point of zinc iodide, and not above 457° C., which is the melting-point of argentic chloride; so 449° to 450° C. is the temperature at which arsenic volatilises. These experiments were repeated several times with same results.

The statements I refer to are—

"Watts's Dictionary,"	180° C.
"Miller's Chemistry,"	180° C.
"Graham's Chemistry,"	180° C.
"Gmelin's Chemistry,"	dull red heat.
(Mitchell),	dull red heat.

Private Laboratory,
Sword Street, Glasgow.

ON PORTLAND CEMENT.*

By Mr. WATSON.

Presuming that the members of this Society are not so conversant with the history of the manufacture of Portland cement as with that of soda and its compounds, I will venture to preface this short paper with a biographical sketch of the former, commencing at its birth.

In the year 1824, Mr. Joseph Aspdin, of Leeds, in the county of York, master bricklayer, made application at the Patent Office to protect a process for making cement or artificial stone for stuccoing buildings, water-works, cisterns, or any other purpose to which it may be applicable, and which he called Portland cement. The process of manufacture described in his specification is as follows:—

"I take a specific quantity of limestone, such as that generally used for making or repairing roads, and I take it from the roads after it is reduced to a puddle or powder, but if I cannot procure a sufficient quantity of the above from the roads, I obtain the limestone itself and cause the puddle or powder ,or the limestone, as the case may be, to be calcined.

"I then take a specific quantity of argillaceous earth or clay, and mix them with water to a state approaching impalpability, either by manual labour or machinery. After this proceeding, I put the above mixture into a slip pan for evaporation, either by the heat of the sun, or by submitting it to the action of fire or steam conveyed in flues or pipes under or near the pan, till the water is entirely evaporated. Then I break the said mixture into suitable lumps, and calcine them in a furnace similar to a lime kiln, till the carbonic acid is entirely expelled. The mixture so calcined is to be ground, beat, or rolled, to a fine powder and is then in a fit state for making cement or artificial stone."

Although Monsieur Vicat, the eminent French chemist, as well as others had succeeded in producing hydraulic cement, closely akin to Aspdin's Portland, long before the date of his specification, and that also by the admixture and burning together of various calcareous and argillaceous substances, there is little doubt that the manufacture of the material known as Portland cement dates from that epoch when Mr. Aspdin filed his specification. How he discovered that the scrapings of the Yorkshire roads could be turned to such good account, there is not evidence to show, but we have proof sufficient that these scrapings when subjected to the manipulation of the observant Yorkshireman, became the pioneer of an important branch of manufacture.

Almost at the same time that Aspdin was experimenting and accomplishing great things with his road mud, Sir C. W. Pasley, of the Royal Engineers, who was stationed at Chatham, was exercising his mind and making elaborate experiments with a view of improving his knowledge of mortars for building purposes, and after sundry trials and failures, he succeeded in making cement identical with Aspdin's Portland, but produced from the chalk and clay of his locality.

Thus, it is curious to observe, Portland cement had its birthplace, although Aspdin had the honour of christening it, in two different places almost simultaneously, and while one inventor secured his raw materials from the hard calcareous and argillaceous formations of the Oolitic system, the other supplied himself from the soft cretaceous chalk strata and the slimy fluviatile accumulations of the post-tertiary period.

Portland cement, like most other young and tender things, was subjected in its early youth to the fierce winds of criticism, and the severe and biting blasts of prejudice, but, as is usually the case when a good thing is offered to the British public, it quickly gained reputation and waxed strong in favour, year by year increasing in demand up to the present, and I think I am under-estimating when, taking last year's statistics as a guide, I calculate the present production in England to exceed *half-a-million* tons per annum. The contagion for making Portland cement has likewise spread beyond the shores of the British Isles, a considerable quantity being now made at various places on the Continent where suitable materials are procurable.

Until very recently the process adopted and the machinery employed in the manufacture of Portland cement have varied very little indeed; the *modus operandi* may be described in a few words. The chalk and clay are thoroughly mixed in a pug or wash mill with a large proportion of water amounting to three or four times the weight of the materials. After being well and carefully incorporated, this liquid slurry is pumped or conveyed by other mechanical means to becks or settling ponds, where the heavier portion of the slurry subsides, leaving the superincumbent water necessary for the mixing on the top; this settlement takes many weeks to complete, the water is gradually drawn off, leaving a substance technically called "slip" at the bottom of the beck. This slip is then conveyed by barrows and spread on flats, where it is dried, the requisite heat being derived from coke ovens built beneath the flats. When the moisture is all evaporated, the dried material is removed and loaded into kilns adjoining, fuel being added

* A paper read before the Newcastle-upon-Tyne Chemical Society, February 26, 1880.

sufficient for the requisite amount of calcination, the waste heat and gases being liberated through the chimney or sugar loaf cone of the kiln, which few will have failed to observe who have ever been in the vicinity of a Portland cement manufactory. After the important process of calcination is completed, the clinker is drawn from the kiln, conveyed to the mill, then ground by horizontal millstones and is ready for the consumer.

To those who have been able to follow this rough description it will be apparent that the aim of the cement maker is, in the first place, to secure a thorough and uniform mechanical incoporation of the raw materials he has to deal with; secondly, to preserve or sustain that intimate relationship during the drying process; and, thirdly, to induce perfect and equal chemical combination of the component parts by the application of heat.

It is almost needless to remark that, of course, the primary step is the selection of raw materials suitable for manipulation, and then to decide upon proportions necessary for a successful result, which can only be arrived at by a careful chemical analysis. The object of the cement maker is to produce a mechanical mixture of carbonate of lime and silicate of aluminia, the proportions of which are so evenly balanced that only sufficient lime is present to enter into chemical combinations with the silica and alumina in the clay, and produce a double silicate of lime and alumina.

Although the method of manipulation described is still extensively adopted, yet, like all other devices of man, it is crowded with imperfections, and among the multitude of these shortcomings a few may be mentioned. The chalk usually employed does vary either in chemical proportion or specific gravity to any extent, but the alluvial deposits are not so uniform in their character. A formation of clay has been found to vary continually, more particularly as regards its specific weight, or rather the weight of the particles composing the formation. Take as an instance the uncombined silica, which is present more or less in every alluvial deposit. The high specific gravity of these uncombined particles as compared with the other substances present, naturally causes them to separate from the remaining portion of the conglomeratic mass, when the agitation of the mixing process ceases, unless the solidity of the mixture is sufficiently dense to hold those silicious molecules in suspension. A percentage of uncombined silica is not an objection in the process of cement making, provided the proportion is not in excess, the particles are not coarse, and the quantity is equally diffused throughout the mixture. These varying properties in weight lead to serious results in the settling becks, unequal subsidence occurring, thereby rendering a perfect chemical combination in the process of calcination impossible.

Another difficulty presents itself in the serious wear and tear and continual dilapidation of the drying flats, in consequence of the unequal and sudden expansion and contraction of the floor, unavoidable when subjected to the influence of the heat given off from the coke-ovens beneath, and the frigid temperature of the semi-liquid slurry when deposited on the floor above.

The liberation of the waste heat given off from the kilns, without an attempt at utilisation, is also unquestionably an imperfection.

I have drawn your attention to the shortcomings of the cement maker, with the hope that you will appreciate a hasty description of some improvements which have recently been introduced in the manufacture of Portland cement.

Johnson's patent chamber-kiln most effectually annihilates two of the objections just referred to, inasmuch as it takes the place of the extravagant flats and coke-ovens, and serves to utilise the waste heat given off from the kiln. Mr. Johnson's invention consists of a kiln of the ordinary construction; but, instead of being surmounted with the usual cone, through the top of which the waste heat is liberated, it is arched over, forming a crown of semi-circular shape. One side of this arch is continued with a flat bottom, in a horizontal direction, forming a semi-circular flue of chamber, supported on piers or ground work. The waste heat from the kiln traverses the length of this flue, and eventually escapes through a chimney at the further end. When the kiln is charged, the liquid slurry from the wash mill is pumped or conveyed through pipes to the top of the flue or chamber; these pipes are furnished with outlets through which the slurry flows, dropping through manholes on the roof of the chamber, and finally depositing itself on the floor of the same, which is composed of ordinary concrete.

Sufficient material having entered the chamber requisite for the re-charging of the kilm, the manholes and other apertures are closed, the kiln is fired, and the heat evolved, passing over the slurry in the flue or chamber, thoroughly dries the material ready for the re-loading of the kiln. Thus the heat given off from one charge is made to dry the slurry requisite for the re-loading. The chamber is constructed of sufficient height to enable a workman to move about in it conveniently.

When describing the process of mixing the crude materials in the wash mill, I mentioned that a large proportion of water is necessary to secure thorough amalgamation. As this large amount of water requires to be drawn off again through the agency of the objectionable subsiding ponds, or by evaporation where the patent chamber kiln is employed, it is obvious that any system which will ensure satisfactory results, and at the same time will allow the manipulator to dispense with a large proportion of this water, is very valuable. Goreham's patent system possesses this advantage. Mr. Goreham subjects the materials to a process of wet grinding, which takes the place of washing. The chalk and clay are thrown together into a mill exactly similar to the old-fashioned arrangement, but instead of being reduced to a liquid with the usual large proportion of water, they are brought, by the addition of only one-third their weight of water, to a consistency just thin enough to flow out of the mill. But as this mixture contains a large proportion of coarse particles of the aggregates, which require further reduction, the mixture is passed through horizontal millstones.

By this process the particles are speedily reduced to an impalpable paste of sufficient solidity to render the intermediate process of settlement unnecessary, and the evaporation in the patent chamber an easy task.

Several cement manufactories have recently adopted the combined processes of Johnson's chamber kilns and Goreham's wet grinding, with results far exceeding their most sanguine expectations, and can it be wondered at? When new appliances are introduced in the process of any manufacture, the adoption of which results in the economy of fuel and labour, as well as greatly diminished space requisite for manipulation, the advantage gained by the manufacturer must be considerable; but, if these economical changes can at the same time ensure *higher perfection* in the *quality* of the finished manufacture, the value of those appliances cannot be over estimated.

In conclusion, I would remark that since these improvements have been introduced, rendering the difficulties previouly referred to things of the past, and imparting to the manufacturer almost absolute control over the varied physical changes of the crust of the earth, I am led to believe from experiments, and the practical experience of others as well as myself, that the day is not far distant, when, aided by the chemist, the geologist, and the engineer, Portland cement makers may seek a wider field for their raw materials than the oceanic deposits of the chalk system and the alluvial clays of the tertiary period.

Decomposition of Cinnabar by Hydrochloric Acid.—The sulphide of mercury whether black and amorphous or red and crystalline is attacked by chlorine, according to the temperature and concentration of the acid.—*Zeitschrift d. Allgem. Oesterr Apoth. Vereins.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, April 15, 1880.

Prof. H. E. Roscoe, President, in the Chair.

The following certificates were read for the first time:—E. Rawson, Kamze Lal Dey Rai Bahadour, Tarapwsanna Roy, of Calcutta, and R. G. Watts. The following gentlemen were balloted for and declared duly elected Fellows of the Society, Prof. McLeod and Dr. Wright being appointed scrutators:—M. Bechler, A. W. Black, E. C. Copas, W. J. Dibdin, A. C. Fryer, E. C. Graham, C. H. Gimingham, R. Grimwood, W. F. Haydon, H. Liepmann, F. B. Last, W. Robinson, W. Regester, J. W. Stanley, H. H. Slater, A. J. Smith, H. C. Stephens, C. P. Scheibner, J. R. Skelton.

The following papers were read:—

"*On the Lecture Illustration of Chemical Curves*," by E. J. Mills. The author has contrived for lecture illustration an apparatus extremely concrete in its effect, in which a chemical action or process constructs its curve under the eyes of the observer. It consists of eighteen tall glass cylinders, of about 270 c.c. capacity, which are filled with water and inverted in as many glass troughs, the cylinders being supported at equal distances from each other in a sort of test-tube frame. Each inverted cylinder has a 100 c.c. stoppered retort, so arranged that its beak can be made to dip under the mouth of the cylinder, the whole forming a series of gas generators and pneumatic troughs, arranged at equal distances from each other. With this apparatus the author has examined the action of dilute sulphuric acid on zinc, and sodic hydrate on aluminium, the two factors, which were varied, being the strength of the solution and the time during which the action was allowed to take place. Thus, equal pieces of clean zinc were placed in each of the retorts, the strength of the acid rising in successive retorts by 3 per cent. Thus various amounts of hydrogen were evolved and collected in the inverted cylinders. The surfaces of the water in the eighteen cylinders were then found to assume a curved line representing the course of the action. This the author designates a quantity curve. Similarly, by increasing the time during which the action was allowed to proceed by equal increments, another curve was obtained—the time curve. The errors in the method are pointed out, but a sufficiently accurate general impression will be conveyed of the true curve, as the eye neglects the small variations.

After a few remarks by Mr. W. Thorp, who had seen the experiments in Dr. Mills's laboratory, and who confirmed the care taken to ensure identity of conditions as to the zinc, temperature, &c.,

The President called on Mr. W. H. Perkin to read his paper "*On the Analysis of Organic Bodies containing Nitrogen*" (continued). In the previous portion of the paper the author proposed to absorb the oxides of nitrogen formed during the combustion of nitrogenous substances by potassic chromate instead of decomposing them by metallic copper. In the combustion of uric acid oxide of copper was used: as some of this was reduced, it might be argued that the good results were partly due to the metallic copper and not to the chromate. Therefore, to test the process still further, combustions were made with plumbic chromate instead of oxide of copper, and it was found that the potassic chromate did not satisfactorily absorb the nitrous fumes. A quantity of precipitated manganic oxide was now made into a paste with a saturated solution of potassic chromate, and the mixture dried and heated somewhat strongly to drive off most of the water of hydration. The efficacy of this mixture was tested by its power of absorbing the red fumes evolved when plumbic nitrate is heated. When the mixture was heated to a dull red heat, some of the nitrogen oxides passed, but if kept at a lower temperature the absorption was complete. The mixtures used consisted in one case of 1 part of chromate to 2 of manganic oxide; in others, of 2 parts of chromate to 1 of manganic oxide: both mixtures seemed to answer equally well. Combustions with dinitro-benzene and with ethyl-ortho-toluydin gave very satisfactory results. The author recommends potassic chromate containing 10 per cent of potassic dichromate, as the commercial precipitated manganic oxide may contain potash; powdered pyrolusite will not act satisfactorily. In making combustions, about 6 inches of the mixture are placed in the front part of the tube (the oxygen process being used). The whole of the tube is heated and dried with air in the usual way. The temperature of the mixture is then allowed to fall to about 200° to 250° C. (in the combustion furnace used by the author, about one-fourth of the burners were kept alight and were half turned down). The combustion is proceeded with in the ordinary way. By re-heating the mixture strongly and passing a current of air, the oxides of nitrogen are removed and the mixture is ready for a second combustion. Thus the same mixture has been used seven times. If the organic substance contains sulphur, a greater length of the mixture must be used, the back part being strongly heated to absorb the sulphur dioxide, and the front part maintained at 200° to 250° to absorb the oxides of nitrogen.

The President said that all present could appreciate the value of this convenient method. The author had hit on a blot in our methods of organic analysis, and apparently completely removed it.

Dr. Wright commented on the great boon the author had conferred on analysts by the introduction of this method.

The President then called on Prof. McLeod to communicate some results obtained "*On the Volatilisation of Solids in Vacuo*," by W. Douglas Herman. Prof. McLeod, requiring some pure phosphorus, endeavoured to obtain some by distilling ordinary phosphorus in an atmosphere of carbon dioxide, but without success. He then wrote to Mr. Herman, who had been investigating the question, enquiring where his paper on the subject was published. In reply, Mr. Herman forwarded the present communication with a request that he would read it. The paper, however, was incomplete; Prof. McLeod therefore gave an abstract of the paper, with a short account of some experiments he had himself made, and exhibited some illustrative specimens. Mr. Herman sealed up some phosphorus in glass tubes containing air, and in vacuous tubes. On distillation in the light the phosphorus in the vacuous tubes condensed in minute yellow crystals. When, however, the distillation was conducted in the dark, most beautiful colourless transparent adamantine crystals were obtained. The phosphorus was dried with filter paper. The author states that when these crystals were exposed to daylight they became rough and opaque, and at the same time yellow or red. As regards the opacity, Prof. McLeod has obtained somewhat different results. Mr. Herman also observed that when phosphorus was heated in sealed tubes to 140° it became surfused, and remained in the liquid state for some months after cooling. This phosphorus turned red in the sunlight. It was interesting to note that the red amorphous phosphorus could therefore be obtained from solid, liquid, and gaseous phosphorus by the action of light alone. In one case a crystal of phosphorus was obtained 8 m.m. long. Mr. Herman also made some most interesting experiments with sulphur. Sulphur sealed up in vacuous tubes distilled over at the temperature of boiling water, *i.e.*, 11° below its melting-point, and condensed in minute drops of liquid sulphur, forming a cloud on the glass. After a time minute crystals appeared and began to grow, the liquid disappearing *pari passu*, until the whole was converted into crystals. Similar ex-

periments were made with iodine, selenium, ammonium chloride, &c. Prof. McLeod then gave an account of the experiments he had made. He had sealed up phosphorus in glass tubes, carefully absorbing all moisture, by melting the phosphorus in a bulb connected with a second bulb containing phosphoric anhydride. He had obtained most beautiful crystals, some of which were exhibited. They resembled in appearance diamonds, being perfectly colourless, with an adamantine lustre, perfectly transparent, and from their high refractive index sparkling with prismatic colours. Prof. McLeod had not been able to confirm Mr. Herman's statement that these crystals became opaque in daylight, and thought that this was due to the presence of a trace of water containing a trace of air; as from experiments he had made, by distilling some phosphorus as above described and then exposing it to the action of boiled water and light, the crystals became red, but remained transparent. If, however, unboiled water was used a white coating was formed similar to that on ordinary phosphorus kept under water and exposed to light.

The PRESIDENT had listened with great interest to the lucid explanation given by Prof. McLeod; as to the specimens they would speak for themselves. He hoped Mr. Herman would finish and publish his paper, and especially complete the interesting observations about the volatilisation of sulphur.

Mr. WARINGTON then communicated a paper "*On the Determination of Nitric Acid as Nitric Oxide by means of its Reaction with Ferrous Chloride.*" The author has previously communicated some results on the determination of nitric acid by Crum and Frankland's process: with small quantities of nitric acid; in the presence of sugar and other organic matter, the results were always low. Schlœssing's method was therefore examined, which consists in boiling the solution of the nitrate in a flask until all air has been expelled, and then boiling with strong solution of ferrous chloride and hydrochloric acid for ten minutes. The nitric oxide is collected over mercury, oxidised into nitric acid, and titrated. An atmosphere of carbonic anhydride was then used to displace the air: in this way results were obtained equal to 95 per cent of the nitrogen taken. When cane-sugar, gelatin, &c., were added the results came too low; but by increasing the quantity of ferrous chloride good results were obtained. Another modification largely used consisted in collecting the gas over caustic soda. As the quantities of nitric acid to be determined by the author were extremely small, being equal to 5 to ½ m.grm. of nitrogen, it seemed to him best to estimate the nitric oxide given off by gas analysis. A chloride of calcium bath was also introduced for heating the nitrate, the best temperature being 130° to 140° C. It was found that however long the mixture was boiled, bubbles of gas were being constantly evolved, due to the introduction of air with the hydrochloric acid. However, with small quantities (5 and 1·4 m.grm.) of N, gas = 99 per cent of the N was obtained. On analysing this gas it was found to contain only 95 to 87 per cent of N. It was noticed when sugar was present that much brown fluid distilled over, and on examination it was found that a marked diminution of the gas took place by allowing it to stand over caustic soda, and especially with caustic soda and the brownish distillate, as much as 42 per cent of nitric oxide being thus absorbed with the caustic soda alone; so the author cannot help thinking that many analyses in which the gas has been collected over caustic soda are in rather a perilous condition. If the gas is analysed at once, before much absorption has taken place, the error is not large. The author then described the apparatus which he found to be most convenient. It consists of a double-necked globular receiver. From one end passes the delivery-tube; through the other, a tube for a stream of carbonic anhydride, and a somewhat long vertical tube furnished with a stoppered funnel at the top for introducing the hydrochloric acid. The air is first cleared out by passing carbonic anhydride for thirty minutes the acid is then introduced, and the solution evaporated to dryness by the chloride of calcium bath at 138° to 140°; the nitric oxide swept out by carbonic anhydride and analysed. In this way, with 1·14 m.grms. of N, results =92·9 per cent were obtained. Sugar and organic matter have no effect on the results. The author mentioned, in conclusion, that a strong solution of ferrous chloride was extremely useful for absorbing nitric oxide.

Dr. ARMSTRONG suggested the use of the Sprengel pump instead of a stream of carbonic anhydride to get rid of the air.

The next paper was taken as read. "*On the Six Possible Isomeric Dibrom-toluols, and other of the Bromo- and Bromo-nitro-derivatives of Toluol related thereto,*" by R. H. C. NEVILE and A. WINTHER. In the table given by Körner in his memoir on "The Isomerism of the Aromatic Compounds containing Six Atoms of Carbon," the rule is laid down that on introducing one of the halogens or the nitro group into aniline it takes the para position. Körner's paper deals only with the substitution of the second hydrogen atom in mono derivatives of benzol, and consequently in this case only with aniline. But it appears to the authors that the rule is of more general application, and that if bromine, or the other halogens, or the nitro group, be caused directly to act upon aniline or its homologues, toluydin, xyliden, &c., or probably other amido compounds, the acid group nearly always, if possible, takes the para position to the amido group. If the para position be occupied by any other group, it then takes one of the ortho positions, but under no circumstances can one of the above acid groups be directly introduced into a position meta to the amido group. The authors think that the above rule will also hold good with diamido compounds. Some experiments of Wrobleosky (*Jahrs.*, 1870, 528, and 1871, 450) appear to point to conclusions at variance with the above theory. The authors have therefore repeated his experiments, and established the correctness of the above theory against the experiments of Wrobleosky. They obtained a brom-nitro-toluydin (m.p. 180·3°), having the constitution—

$$\underset{1.}{CH_3}\ \underset{2.}{NH_2}\ \underset{3.}{Br}\ \underset{5.}{NO_2},$$

the constitution of Wrobleosky's substance (m.p. 139°) being—

$$\underset{1.}{CH_3}\ \underset{2.}{NH_2}\ \underset{3.}{NO_2}\ \underset{5.}{Br},$$

and ordinary nitro-ortho-toluydin—

$$\underset{1.}{CH_3}\ \underset{2.}{NH_2}\ \underset{5.}{NO_2}.$$

The authors next consider the dibromo-toluol in which both the bromine atoms are meta to the CH_3 group, and promise a further communication on the dibromo-toluol 1, 2, 6, and the tribromo- and tetrabromo-toluols. The paper is lengthy, and contains detailed accounts of the preparation and analysis of the numerous compounds investigated.

The Society then adjourned to May 6, when the following papers will be read:—"On the Action of Sodium on Ethereal Salts of Phenyl-acetic Acid," by Dr. Hodgkinson; "Estimation of Nitrogen in Carbon Compounds," by C. E. Groves; "On Sage Oil," by M. M. P. Muir. It was also announced that the discussion on Dr. Tidy's paper, "On River Water," will take place on May 20. (The paper will be printed early in May.)

A Case of Permanent Polarity in Steel opposed to that of the Magnetising Coil by which it is Produced.—A. Righi.—The author finds that on taking bars of the same steel and of the same diameter but of decreasing lengths, we arrive at a certain length which no longer yields any magnetisation, whilst with smaller lengths we obtain a permanent polarity opposed to that of the coil.—*Comptes Rendus.*

NOTICES OF BOOKS.

Saint Germain-en-Laye. The Sewage of Paris. Operations of the Committee of Defence against the Projects of Stripping and Irrigating the Forest of Germain. (Eaux d'Egout de Paris. Travaux du Comitè de Défense contre les Projets de Déboisement et d'Irrigation de la Forêt de Saint Germain-en-Laye.) Saint Germain : Bardin. Paris : Dunod.

(Second Notice.)

It is an indisputable fact that if we fill a flower-pot with any garden-mould, or any fair average arable soil, and pour upon it a glass of town-sewage, the water will trickle out below deprived of its offensive smell, of its colour, and freed to a great extent of its objectionable constituents. It is also a fact that sewage applied to land in moderate quantities and in time of drought, or when the state of the crops renders a supply of moisture needful, produces most satisfactory results. But these facts by no means warrant the conclusion of sewage-irrigationists that the liquid refuse of a town can thus be got rid of the whole year round. The supply is constant, the demand intermittent. The town always wants to get rid of its sewage, and the land is not always in a state to receive it with advantage. The fields of France, like those of England, are often moistened enough, and more than enough, by the rain and by the rise of rivers. To admit more liquid over them at such a time must simply be to convert the soil into semi-fluid mud. Consequently at such times the farmers and gardeners will not accept the sewage. Nor can the difficulty be overcome by enlarging the irrigated area. Excessive rains are not commonly confined to small patches of land, and if one plot of, say, a thousand acres, is water-logged, as a rule the adjacent plots on every side will be in the same condition.

At Gennevilliers, one particular plot of the irrigated land is known as the "town garden," and is kept in apparently good condition by a most lavish expenditure of labour. Whether the produce obtained covers the cost of production is, to say the least, very doubtful. Whether a larger area, such as that proposed to be formed at St. Germain, would or could be as skilfully and carefully managed is also much to be questioned. Everyone knows that the market-gardener above all things seeks to bring his produce to a saleable condition as early as possible. But this end cannot be accomplished by irrigation, which, as every physicist knows, must tend to lower the temperature of the soil. Hence the vegetables of Gennevilliers never arrive early in the market. The irrigation grounds only give a luxuriant yield in the height of summer, when vegetables are produced plentifully everywhere, and have consequently become a drug in the market. This objection to irrigation falls away in hot climates, a circumstance overlooked by certain enthusiasts, who fail to see that what confers fertility in India may prove rather injurious in England.

The crops cultivated at Gennevilliers are few. Cabbages and artichokes are very abundant, and we find also peppermint, wormwood, a few strawberries, and some fruit trees. Grain is exceptional, and when planted it is rarely and sparingly irrigated, and is cut green for the use of cattle. Cabbages are perhaps the leading feature in the irrigated portion of the peninsula of Gennevilliers, and their cultivation requires a great amount of labour. The ground must first be laid out in ridges and furrows, so levelled as to permit the proper flow of the sewage. When the cabbages are mature the soil must not merely be turned over, but those parts where the plants have grown must be mixed with those which formed the furrows, and then the whole plot must be laid out anew. Nor must it be supposed that the sewage-fed cabbages, though often large, are crisp and firm, like those grown in a rich but unirrigated field. It is very easy to thrust the finger up to the knuckle into the heart of one of the Gennevilliers cabbages.

There are some meadows along the road from Gennevilliers to Asnières, but these are only irrigated for a short time after the grass is cut, and the sewage is then turned off while it grows. The grass is not adapted for conversion into hay, but is fed immediately when cut. With all possible care in clearing out the furrows the surface of these meadows becomes matted, and it is found necessary to turn the soil over and lay them down to grass again. The grass, moreover, is found to have a purgative action, which unfits it for the regular food of cattle.

The Defence Committee are far from pronouncing sewage irrigation as injurious under all circumstances. They consider that a farmer who should have a supply of sewage at his command, and who could use it at certain seasons of the year or in certain states of the weather, would find it very advantageous, but it is obvious that such irrigation could play no appreciable part in the regular disposal of the sewage of a great city.

It must be admitted that for an experiment on the disposal of sewage on this principle Gennevilliers enjoys an exceptionally favourable position. The soil is deep and uniformly porous, neither apt to retain the water in pools on its surface nor to let it pass through cracks. All garden-produce finds a ready market in Paris without the expense of a long carriage. Yet with all these advantages the success of the scheme is as dubious in a financial respect as it is from the point of view of public health and convenience.

At St. Germain-en-Laye all conditions are less favourable. The surface of the soil is of a more retentive nature, *e.g.*, near Nanterre and Bezons, where pools, formed by the inundations of the Seine, have been known to remain for four months until dried up by evaporation. What a district for irrigation! The distance from Paris is also considerable, and farm- and garden-produce can consequently only find a market at a very tangible outlay for carriage. In fine, the project may be described as an attempt to convert a pleasant district into a focus of malaria without the excuse of profit.

The results at Gennevilliers are simply what we have always expected,—another case of the unsatisfactory working of irrigation in a high latitude and a moist climate.

On the Constitution of the Naphthalins and of their Derivatives. By F. Reverdin and E. Noelting. Geneva : H. Georg.

This treatise comprises evidence in support of the formula for naphthalin as proposed by Erlenmeyer and Graebe ; an account of the isomerism of the derivatives of naphthalin and of their constitution. An appendix gives the bibliography of the subject. The well-known reputation of the authors will be a sufficient guarantee for the accuracy and thoroughness of this monograph, and render it valuable as a work of reference to all engaged in the study of this interesting class of compounds.

The Scale-Photometer : a New Instrument for the Mechanical Measurement of Light, along with Contributions to the History and Theory of Mechanical Photometry. (Das Skalen Photometer: ein Neues Instrument zur Mechanischen Messung des Lichtes.) By Friedrich Zöllner, Professor of Physical Astronomy at the University of Leipzig. With four illustrations and an Appendix to Vol. III. of the "Scientific Treatises" on the "History of the Fourth Dimension," and on the Hypnotic Experiments of Professor Weinhold. Leipzig: Staackmann.

The author was, so far back as 1857, engaged with the construction of a "polarisation-photometer." At that time the physiological and the chemical effects of light afforded the only known means for the determination of its intensity. In optical investigations, however the construction of the instruments might vary, everything ulti-

mately turned upon the power of the human eye to recognise the degrees of brightness of two surfaces, placed in close juxtaposition under favourable circumstances. If photometry was ever to be removed from the region of physiology to that of physical measurement, properties of light must be discovered and utilised which are capable of leading to measurable changes in space, *i.e.*, visible movements. This want, which the author experienced twenty-three years ago, is supplied by the aid of the radiometer. He points out very distinctly that Mr. Crookes, from the very outset of his discoveries, carried on experiments in this direction, and made various proposals for the construction of suitable photometers. If, for instance, the ultra-red rays of the spectrum—*i.e.*. the invisible heat-rays—are cut of by means of a concentrated aqueous solution of alum, and the ultra-violet, or invisible, chemical rays are at the same time kept off by a solution of quinine sulphate, the radiometer can then be affected solely by those rays which otherwise act upon our sight, and which therefore are called light in the strictest sense of the word. Under these circumstances the radiometer becomes a true photometer. Professor Zöllner claims, therefore, not the principle, but simply the form and the construction of the scale-photometer. An intelligible description of the instrument cannot, of course, be given without the aid of the illustrations which accompany his treatise.

As might be expected, the two principal theories brought forward to explain the action of the radiometer are here carefully and minutely discussed. Concerning the view which has found most favour in this country Prof. Zöllner thus summarises his results:

"The explanation of the radiometric movements based upon the principles of the kinetic theory of gases makes assumptions concerning the relation of the mean way traversed by the gas-molecules to the dimensions of the receivers which do not exist in reality.

"This explanation, further, without advancing any sufficient reason, ignores the simultaneous existence of the vapours of mercury whose molecules have a mass more than sevenfold greater, and travel a much smaller mean distance than the molecules of the gas which is supposed to be active by the mechanical theory.

"Hence we are not entitled to behold in the radiometric phenomena discovered by Mr. Crookes an empirical confirmation of the kinetic gas theory."

Into the subjects treated in the appendix we cannot enter further than to ask those who use the word "hypnotism", a term invented, we believe, by a Dr. Braid, of Manchester—whether it really throws light upon any phenomena, physical, biological, or psychical, or whether it is not one of those unmeaning expressions which men so often put forward to hide their own ignorance?

Die Explosiven Stoffe, ihre Geschichte, Fabrikation, Eigenschaften, Prüfung, und Praktische Anwendung. (Explosives: their History, Manufacture, Properties, Examination, and Practical Application.) Von Dr. Fr. Böckmann. Vienna, Pest, and Leipzig: A. Hartleben.

This treatise forms the sixtieth volume of a useful series of works entitled the "Chemico-technical Library" (*Chemisch-technische Bibliothek*). The author in his introduction points out the great development, or it might almost be said the revolution, which has taken place in the manufacture and in the very nature of explosives. He fully admits, however, that where sustained propulsion is required, as in case of projectiles, ordinary gunpowder still remains not merely unsurpassed, but without a rival. Where a sudden bursting shattering power is required it takes a very low rank in comparison with nitro-cellulose and nitro-glycerin.

Entering into the theory of explosives, he defines them as solids or liquids which can suddenly assume a gaseous condition. In so doing they occasion that sudden, violent, and irregular agitation of the air known as explosion. Most of them contain an oxygen-bearer, *i.e.*, a solid or liquid body containing oxygen in a state of unstable combination, so that it may be readily transferred to carbonaceous matter present, the final products of the reaction being carbonic acid, watery vapour, and nitrogen. This rule is, of course, not without exceptions, as in case of nitrogen chloride and iodide, which contain neither oxygen nor carbon, and whose explosion is not so much a combustion as a simple falling to pieces.

The author divides the substances of which he treats into two classes—those directly explosive, gunpowder, loose gun-cotton and its analogues, nitro-mannite, nitro-glucose, picric acid, &c.; and those which are only indirectly explosible, such as compressed gun-cotton and nitro-glycerin with its mixtures.

As regards the history of gunpowder, the author considers it as decided that the invention was due neither to Roger Bacon nor to the German monk, Berthold Schwartz, whose very existence is questionable, but must rather be sought in India or China, and at a date anterior to the Christian era. In the eighth century, Marcus Graccus, in his work "Liber Ignium," gives a receipt for an explosive mixture which does not differ widely from modern gunpowder. He takes 1 part of sulphur, 2 of charcoal, and 6 of saltpetre, and he recommends the wood of the willow as the best material for the preparation of the charcoal. The first introduction of gunpowder in mining operations appears to have been after the Thirty Years' War.

The manufacture of gunpowder is described with great thoroughness, from the sources and preparation of the three ingredients downwards. The best charcoal, it appears, is that obtained from the stalks of hemp, but only the hemp of the more southern parts of Europe is sufficiently well developed for this use. The use of superheated steam for the carbonisation of wood was found less advantageous than charring in ordinary cylinders, at least as far as military powder is concerned. The yield is smaller and the first outlay greater.

After completing his exhaustive account of ordinary gunpowder, he proceeds to mixtures of analogous character, but in which, instead of saltpetre, sodium or barium nitrate, or potassium chlorate or perchlorate, are partially or wholly introduced.

The author justly pronounces the white gunpowder of Augendre—a mixture of potassic chlorate and ferrocyanide with sugar—dangerous, as we know from personal observation. Passing over Sprengel's preparations—in which trinitro-benzol and picric acid are employed—and the picrate powders of Borlinetto, Designolle, and Brugère, we come to the most important class of modern explosives, those produced by the action of concentrated nitric acid upon organic matter. The discovery of gun-cotton (nitro-cellulose) by Braconnot, Pelouze, Schönbein, Böttger, and Otto, and the great improvement in its preparation due to Lenk, are described very fully. The process of the latter, as most of our readers are aware, has been still further developed by Prof. Abel, and is carried on in England on a large scale. The account of the manufacture of gun-cotton, as carried on at Stowmarket* and at Waltham Abbey is both accurate and minute. He considers nitro-gelatin—otherwise known as gelatin-dynamite—will prove the most formidable rival of gun-cotton if it can be rendered less sensitive to the effects of shocks, or explosions which may be produced near at hand—*e.g.*, by an enemy's fire or by the discharge of a mine or a torpedo.

We come next to nitro-glycerin and its various disguises, such as dynamite. It must be remarked, however, that the author uses this word generically, so as to include not merely the ordinary dynamite—a mixture of nitro-glycerin with infusorial earth or with china-clay—but such explosives as lithofracteur, Brain's powder, lignose, dualin, cellulose dynamite, &c, in which nitro-glycerin is compounded with other explosive bodies. In all these mixtures, as in the original nitro-glycerin and in gun-cotton, the

* We understand that the manufacture of gun-cotton at Stowmarket temporarily at least, suspended.

explosion-point lies considerably higher than the point of ignition.

The second section of the work, at which we can but glance briefly, treats of the practical applications of explosives, and the precautions necessary for their storage and transport, including an abstract of the German laws regulating the carriage of dynamite, &c., by land or water. A summary of the whole art of blasting, and the arrangement of mines and torpedoes, with the various forms given to these destructive appliances, concludes a book which we should have been happy to notice at greater length did space permit.

For manufacturers of explosives, military and mining engineers, this treatise must prove of the highest value. Nowhere else have we seen this important subject treated with such thoroughness and accuracy. The book is plentifully illustrated, and is furnished with abundant bibliographical references.

CORRESPONDENCE.

AMMONIA FROM THE NITROGEN OF THE ATMOSPHERE AND THE HYDROGEN OF WATER.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xli., p. 155, you refer to Messrs. Rickman and Thompson's patent for the production of ammonia (in the form of the chloride) from atmospheric nitrogen and nascent hydrogen. I have since obtained copy of this patent, filed March 15, and find that it is only the preliminary specification, and there is therefore some difficulty of arriving at facts. However, it appears to me, as far as I am enabled to judge from same and your explanatory remarks, that the *bulk*, at all events, of the ammonia obtained by this operation is that given off during the combustion of the coal-dust during the coking process.

Dr. Angus Smith, in his last report in connection with the Noxious Vapours Act, advocates the abstraction of the ammonia for agricultural purposes from the coal used in iron works, &c., and Messrs. Rickmann and Thompson's patent seems well adapted to be worked advantageously in connection therewith, if the ammonia they obtain is, as I surmise, principally from the coal.—I am, &c.,

J. H.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 12, March 22, 1880.

Silver Teroxide.—M. Berthelot.—The author has re-examined the compound first obtained in 1804 by Ritter from the electrolysis of silver oxide. The substance is unstable, and in a short time the black brilliant metallic crystalline needles crumble to a black amorphous powder, with escape of oxygen. This change is accelerated by heat, and becomes explosive a little below 100°. It is also decomposed by washing, the water gradually carrying off silver nitrate. The analysis of the recently-prepared compound shows the composition—$4AgO_3,NO_6Ag,HO$. The author regards it as the silver-salt of an argento-nitric acid.

Decomposition of Potassium Permanganate by Oxygenated Water.—M. Berthelot.—These two compounds, if brought in contact in a strongly acid liquid, are reciprocally decomposed, losing all their active oxygen, and being reduced to the state of protoxide. This change is due to the formation of an unstable compound, whose spontaneous destruction explains the consecutive evolution of oxygen. This new colourless compound is stable at −12° in the medium where it is produced, but is destroyed on assuming the ordinary temperature. The author regards this compound as a hydrogen teroxide formed by the oxidation of oxygenated water by potassic permangate. It is analogous to several peroxides and metallic acids, and to hydrogen tersulphide.

Electric Regulation of Time in Paris.—M. Tresca.—The system employed is composed of a certain number of horar centres distributed over two telegraphic nets and of the clocks of the city kept to the true time, so that the error can never exceed a minute.

Analysis of the Luminous Phenomena Produced by Electric Discharges in Rarified Gases.—E. Fernet.—A large vertical tube, to each of the ends of which are soldered wires serving to pass the discharges of a Ruhmkorff's coil, is placed in permanent connection with a Geissler pump. The tube is placed behind a screen in which is an upright slit. Opposite the slit is fitted a revolving mirror moved by a small turbine, and having its axis of rotation also vertical. The displacement of the image seen in the mirror renders it possible to observe the successive appearances offered by those points of the tube left free by the slit. As soon as the rarefication is sufficient to permit the passage of the inverse induced current, corresponding to the closing of the circuit, as well as of the direct induced current, corresponding to the breaking of the circuit, two images are seen in the mirror. Three of the images thus obtained are figured.

Thermic Laws of Electric Sparks Produced by the Ordinary, Incomplete, and Partial Discharges of Condensers.—E. Villari.—The author proposes the following laws:—(1.) When in a conductive arc there are formed two sparks, one of which is against the discharger, the sum of the heats produced is constant. (2.) The sum of the lengths of the two sparks (one of which is against the discharger) is constant. (3.) The total electric resistance which the two sparks encounter in the gases where they are formed is constant. (4.) The quantity of electricity which constitutes the discharge of a condenser is constant whatever is the length of one of the sparks which are formed in the discharge itself. (5.) The total heat developed by the different sparks of the discharge of a condenser is inversely as its surface.

Photography of the Solar Spectrum.—E. Conche.—The proofs which the author presents to the Academy give the prolongation of the spectrum into the obscure symmetric region of the blue with reference to the extreme red.

Density of Iodine at High Temperatures.—J. M. Crafts and F. Meier.—M. H. Sainte-Claire Deville has not only been the first to study the densities of bodies at very high temperatures, but he has been able to penetrate to the root of the question in his researches upon dissociation, and to reveal to us the causes of many anomalous densities. In the researches of MM. Deville and Troost the density of iodine was determined as normal at 860° and 1040°, and serves as a point of comparison for the measurement of other densities. M. V. Meyer, on the contrary, finds the density of iodine anomalous after 590°. The want of agreement which seems to exist between these results has led us to take up the study of the subject, making use of a different process for the measurement of the temperatures, and a modified apparatus for the determinations of the density. M. Victor Meyer has been so obliging as to communicate some details on his process in order to facilitate a comparison. The precise determination of the temperature seemed to us of the greatest

importance, and we have not made use of the calorimetric method, because, among other reasons, the fundamental data of this method have not yet been thoroughly established for very high temperatures. It has appeared to us doubtful whether all the parts of a cylinder heated by a naked flame take an equal temperature, and in all the following experiments we surrounded the cylinder with an iron or earthenware muffle. We employed for measuring the temperature an air thermometer described in a paper presented at the last sitting of the Academy, and the experiments on density followed immediately after the determinations of temperature. For this purpose the apparatus was transformed by very simple additions into an air thermometer of the ordinary form. It was closed hermetically after the introduction of the vessel containing the substance to be volatilised, and at a given moment this vessel was let fall from the cold part into the hot part of the thermometer, and the increase of volume was read. The iodine had been purified according to the method of M. Stas, by solution in potassium iodide and fractionated precipitation. We give, in the first part of the following table, the results obtained at different temperatures by M. Meyer, and in the second part our own, but we have reasons for believing that the two series of measurements of temperature are not strictly comparable. The columns $\frac{D'}{D}$ give the proportions between the densities found and the theoretic density of iodine = 8·786.

Temperature.	Density.	$\frac{D'}{D}$.
450°	8·84; 8·85	
586°	8·73; 8·71; 8·71	0·99
842°	6·68; 6·80; 6·80	0·77
1030°	5·75; 5·74	0·66
1570°	5·60; 5·67; 5·71; 5·81	0·65
445°	8·70; 8·78; 8·75	
830° to 880°	8·04; 8·11	0·92
1020° to 1050°	7·02; 7·18; 6 83	0·80
1275°	6·07; 5·57	0·66
1390°	5·23; 5·33	0·60

M Victor Meyer concludes from his observations that iodine is dissociated in the same manner as the chlorine evolved from platinous chloride; that towards 1000° the density is reduced to 0·66 of the normal density, and remains constant at this figure up to 1570°, which he regards as the highest temperature of the Perrot furnace. We estimate this same temperature at below 1400°, and at this point we find the density of iodine below the two-thirds, which, according to M. Meyer, would be the extreme limit of the dissociation. We find the decrease of density progressive, without stopping-point, from 600° to the limit of our observations. In other terms, if the cause of diminution is dissociation, we may admit that the molecule I_2 tends to resolve itself into 2 atoms. We hope that further experiments will enable us to draw up a curve expressing with sufficient precision the relation between density and temperature, and the results obtained with the halogens allow us to foreshadow the possibility of finding a relation between the anomalous density and the atomic weight—a relation which it will be useful to seek also in the other periodic groups of elements. We admit that the density is normal for chlorine up to 1350°, decidedly anomalous for iodine, and probably intermediate for bromine. To account for the differences between his observations and those of MM. Deville and Troost, M. Victor Meyer suggests that the rapid evaporation and the presence of a permanent gas may favour the dissociation of the iodine. The second of these hypotheses seems sufficient to explain the small differences between the density which we find for iodine at 860° to 1040°, and the figures of MM. Deville and Troost, and before becoming acquainted with the memoir of M. Meyer we pointed out to the Chemical Society that the ingenious connection established by M. Deville between the phenomena of ebullition and of dissociation may furnish the key for the solution of this problem.

A Method of Producing Acetal.—MM. R. Engel and De Girard.

Specific Heats of Solutions of Potassa and Soda.—M. Hammerl.—The author's results are given in the form of tables.

Alkaloids of the Permanganate Tree.—C. Tanret.—A description of four compounds, to which the author gives the names of pelletierin, iso-pelletierin, methyl-pelletierin, and pseudo-pelletierin. The separation of these bodies and their properties are described.

Artificial Production of a Leucotephrite identical with the Crystalline Lavas of Vesuvius and of Somma: Nascent Crystallic Forms of Leucite and Nephelin.—F. Fouqué and A. M. Lévy.—An illustrated paper, not admitting of useful reproduction.

Artificial Reproduction of Spinel and Corundum.—S. Meunier.—The author brings in contact in a heated tube, aluminium chloride, watery vapour, and metallic magnesium.

L'Orosi. Giornale di Chimica, Farmacia, e Scienze Affini. No. 12, December, 1879.

A New and very Sensitive Method of Detecting Free Hydrochloric Acid in a Solution of Ferric Chloride.—Prof. Nicola Rease.—The author finds that a solution of ordinary phenol treated with ferric chloride takes an amethyst colouration, turning to a brown. But if a drop of hydrochloric acid is added to the solution the liquid either assumes no colouration at all or assumes a greenish tint. He proceeds as follows:—1 grm. of the crystalline phenol of commerce is heated in 100 c.c. of pure water. He then pours 1 c.c. of the liquid ferric chloride into 50 c.c. of pure water. This solution being in a small test-beaker set on a sheet of white paper, the solution of phenol is added drop by drop. The first drop, if the solution is slightly acid, produces a fugitive colouration, but if it is strongly acid no colour appears. On continuing to add the phenol solution the colour becomes permanent and gradually darkens. From the volume of the phenol solution consumed an approximate idea of the quantity of acid present may be formed.

Action of the Poison of Lupins upon Dogs.—Prof. F. Corso.—The poison of lupins is formed of certain alkaloids derived from coniin. The memoir is physiological rather than chemical in its purpose.

Reduction of Nitrates during Metallic Substitutions.—Dr. Giacomo Guetta.—The metallic nitrates, if heated with a metal capable of substituting itself for the metal of such nitrates, are partially reduced to ammonium nitrate. This reduction the author considers is in great part due to the heat liberated during the substitution of the metals, and which is capable of effecting, in the presence of the electric element formed by the two metals, the decomposition of the water, and of communicating to the hydrogen resulting from such decomposition the power of deoxidising the nitric acid and converting the nitrogen into ammonia.

Analytical Observations on Tin, and the Determination of the Limits of Sensitiveness of the Chief Reagents for Bases.—G. Pellizzari.—After attacking with hydrochloric acid the brown flocks precipitated by zinc from a solution which may contain tin and antimony, there is added potassium sulphocyanide and then ammonium molybdate. If a carmine-red colouration appears the presence of tin is indicated. If traces of antimony have been dissolved by the hydrochloric acid the reaction is not interfered with. The tartaric, oxalic, phosphoric, and acetic acids diminish the colour produced, or even prevent its formation. Heat also weakens the colouration.

Journal für Praktische Chemie.
Nos. 1, 2, and 3, 1880.

Acetyl-urea and certain of its Derivatives.—Dr. R. Leuckart.—The supposition that the bodies produced on the one hand from cyanic ether by union with ammonia, and on the other from ethylamin cyanate by the transposition of its elementary constituents are isomeric, but not identical, has not been confirmed. The nature of diphenyl-urea obtained by boiling both bodies with aniline, and of the diphenyl-biuret obtained from the ethyl-allophanic ethers by the same reaction, render it probable that if urea is to be regarded as carbamic amide, both these ethyl compounds must be regarded as carbamic ethyl-amid.

Thermo-chemical Researches.—Julius Thomsen.—The heat liberated in the reaction (R, O_2, CO) in case of most metals lies between those of the reactions (R, O_2, SO_2) and (R, O_2, N_2O_4), but the differences vary widely. Between the anhydrous carbonates and nitrates the difference of the formation-heat rises from potassium to silver, *i.e.*, from 7980 to 31,290 cals. The relation between the sulphates and the carbonates is the reverse, as here the difference from potassium to silver decreases from 22,620 to 3430 cals. On comparing the formation-heat of the sulphates and nitrates, the same approximate difference is found for the potassium, sodium, thallium, and ammonium salts, namely, on the average, 30,480 cals. There is also an almost equal difference for the salts of lithium, silver, lead, barium, and strontium, namely, 35,770 cals.

Thermo-chemical Researches.—Julius Thomsen.—This important paper, which does not admit of useful abstraction, treats of the chief numerical results of the author's investigations on the phenomena of affinity of the metals.

Contributions to a Knowledge of Cyanamid (Second Memoir: See vol. xi., p. 284).—E. Drechsel.—We have here an account of the preparation of cyanamid from potassium cyanate and ammonium sulphocyanide. The author then describes the various methods of its formation, its conversion into other cyanogen compounds and its constitution.

Formation of Fat in the Lower Fungi.—C. v. Nägeli and O. Loew.—The cells of fungi can obtain the materials for the production of fat from the most varied compounds, whether nitrogenous or not.

The Atomic Weight of Antimony.—F. Kessler.—The author considers the determinations of Schneider and Cooke untrustworthy, and regards the correct atomic weight as = 122·3.

Products of the Reaction of Chloro-carbonic Ether upon certain Amine Bases.—Dr. L. Schreiner.—The author obtains four new compounds, all of which are liquids at ordinary temperatures, whilst the urethans are solid, crystalline bodies.

Certain Ethylen Derivatives of Phenol and of Salicylic Acid.—A. Weddige.—The compounds mentioned in this preliminary communication are ethylen-di-para-nitro-phenol, brom-ethyl-para-nitro-phenol, ethylen-diortho-nitro-phenol, ethylen-disalicylic ethyl-ether, and ethylen-disalicylic acid.

Annalen der Physik und Chemie.
Heft 3, No. 11, 1879.

Remarks on Extra Currents in Iron Wires.—H. Herwig.—A reply to Lorenz (*Annalen*, vii., p. 185).

MISCELLANEOUS.

Yorkshire College of Science.—On the 12th inst. Mr. Hummel, the newly appointed instructor in dyeing and tinctorial chemistry, delivered an inaugural address. He explained in a very clear and forcible manner the importance, or rather the necessity, of a scientific training for all persons who engage in the tinctorial arts. He denounced the rule-of-thumb system which so many of dyers still persist in following, and referred to certain "occult influences" which have been long ago exposed in the Chemical News. He pointed out that in the industrial arts, as well as in science, there is only one royal road to success—systematic experiment. He proposes to conduct his pupils through a series of such experiments, in which every influence which can bear upon the results produced will be carefully studied. Mr. Hummel is an hereditary dyer. His father studied under Chevreul, at the Gobelins, and afterwards held appointments at many dye-works in Italy, France, Austria, and Germany. Mr. Hummel, in turn, studied under Prof. Bolley at the Polytechnic School of Zürich, under the late Prof. Calvert at the Royal Institution, at Manchester, and has been engaged as manager in many important dye- and print-works in England and Scotland. After the conclusion of the lecture Prof. Thorpe made some impressive remarks on the neglect of scientific research in England, and pointed out that since 1860 there was scarcely a British name among the list of the discoverers of new colouring matters. He asked how it was that whilst we had a much larger supply of the raw material from which the coal-tar colours are produced, another country should surpass us in their discovery and their manufacture? The speaker found the reason in the higher educational system of Germany, where a university career is not merely very cheap, but where degrees and honours are awarded only to those who have proved their competence by successful research. We cannot but rejoice at so open a protest against the system of cram and examinationism now dominant in England, and we feel every confidence that the Yorkshire College of Science will prove a focus of invention and discovery.

South London School of Pharmacy.—The Medals and Certificates for the term ending the 15th April were presented by the Secretary, on the 17th April, to the following successful competitors:—Senior Chemistry—Medal, Mr. Price; Certificate, Mr. Carruthers. Junior Chemistry—Medal, Mr. Hill; Certificate, Mr. Waring. Materia Medica—Medal, Mr. Williams; Certificate, Mr. Horne. Botany—Medal, Mr. Walkley; Certificate, Mr. Waring. Pharmacy—Medal, Mr. Waring. The Secretary's Prize for Organic Chemistry was presented by the Chairman (Rev. S. Backe Harris) to Mr. W. Williams.

NOTES AND QUERIES.

Polarisation Symbols.—I am sorely perplexed as to the real meaning of the terms [*a*]*j* and [*a*]D, and the relation they bear to each other, as applied to sugars and other carbohydrates. If you can give me any assistance, or direct me to where I can get it, I shall feel obliged.—W.M.C. [The symbols in question express the extent to which the plane of polarisation is made to rotate by the sugars, &c. Their respective value will be found in any work which explains the optical analysis of sugars.—*Ed.* C.N.]

Keeping Salts of Ammonia.—(Reply to H. J. Bland.)—A purchaser of salts of ammonia of English manufacture will certainly experience a loss in weight if the goods are kept in store for any time. Taking the *sulphate* as an example: it contains originally 4 to 6 per cent of moisture—independent of any water of crystallisation—and this moisture is rapidly given off in a *dry* atmosphere; less so during damp weather, and it may even *gain* at first in weight in the latter case, owing to the presence of free (sulphuric) acid, although in a well-made salt this should be very trifling. Keeping it for twelve or eighteen months a loss in weight is unavoidable, and will depend more or less upon the moisture originally present. It is as well to point out, however, that if the sulphate is not stored for re-sale, but by a manure manufacturer to be used up eventually in the preparation of ammoniated compound, there will not be any real loss in money value to the holder, as supposing the sulphate originally contained 24 per cent NH_3 it will in the dry state contain at least 25 per cent, and then the loss in weight by evaporation of water, &c., is made up by the gain in strength of the dry article. The only sulphate that does not lose weight is the American kiln-dried, which has frequently been sold on our markets.—J. H.

TO CORRESPONDENTS.

W. W. Walker.—We do not know of such a work.

MEETINGS FOR THE WEEK.

Monday, 26th.—Medical, 8.30.
— Society of Arts, 8. Robert W. Edis, F.S.A., "The Decoration and Furniture of Town Houses."
— Royal Geographical, 8.30.
— Philosophical Club (Anniversary), 6.30.
Tuesday, 27th.—Civil Engineers, 8.
— Anthropological Institute, 8.
— Royal Institution, 3. Mr. R. H. Scott, "Wind and Weather."
— Royal Medical and Chirurgical, 8.30.
— Society of Arts, 8. Mr. C. G. W. Lock, "Iceland and its Resources."
Wednesday, 28th.—Society of Arts, 8. Thomas Fletcher, F.C.S., "Recent Improvements in Gas Furnaces for Domestic and Laboratory Purposes."
— Geological, 8.
— London Institution (Anniversary), 12.
Thursday, 29th.—Royal Society Club, 6.30.
— Royal, 8.30.
— Zoological (Anniversary), 1.
— Royal Institution, 3. Prof. Tyndall, "Light as a Mode of Motion: Theories of Light and Colour."
Friday, 30th.—Royal Institution, 8. Mr. Spottiswoode, "Electricity in Transitu," 9.
Saturday, May 1st.—Royal Institution. Annual Meeting, 2.

SPECIALITIES.

MANGANESE Finest Crystallised, Lump, Ground, and Granulated of every quality, and Prepared for *Chlorine, Glass, Steel, Ferro-Manganese, Pottery, Battery,* and Every Purpose.

BAUXITE (Hydrate of Alumina) Of high percentage of Alumina and almost free from Iron The Cheapest, Best, and Most Profitable article from which to produce Alum, Alum Cake, and Sulphate of Alumina, &c. [BRAND, "IRISH HILL BAUXITE."]

FLUOR-SPAR Of the Very Finest Quality for Acid, Soda, Glass Flux, and all purposes.

BARYTES (Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

CRYOLITE, Magnesite, Felspar, Arsenic, Phosphates French Chalk, Strontia, Wolfram, Chrome, Terra Alba, Rotten Stone, China Clay, Umbers, Ochres, Antimony, Calamine, Emery Stone, all Oxides, and all

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,
MINE PROPRIETOR,
Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.
OFFICES—26 CHAPEL STREET, LIVERPOOL.

Fletcher's SOLID FLAME Burner.

The Most Perfect Heating Burner for all purposes. It will with equal ease boil an egg, or melt half-a-hundredweight of lead in an iron pot. It will boil half-a-gallon of water in a flat copper kettle in six minutes, or melt 5 lbs. lead in an iron ladle in the same time. Price, in galvanised iron, 4s. 6d.; nickel plated, 5s. It can be made at a low cost of *any shape, size, or power.* New and enlarged list of Gas and Petroleum Heating Burners, Forges, Furnaces, Hot- and Cold-Blast Blowpipes, Ingot Moulds, Foot and Hand Blowers, &c., price 3d., free by post.

THOS. FLETCHER,
4 & 6, MUSEUM STREET, WARRINGTON.

Wanted, a Buyer of 8 to 10 Tons weekly of Crystallised Sulphate of Soda (Glauber salts), in cask or bulk.—Apply to "Glauber Salts," 168, St. Helen's Avenue, Swansea.

GREENBANK ALKALI WORKS COMPANY (LIMITED),
ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums, or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{2}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{100000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

THOMAS ADKINS & CO.,
SMETHWICK,
NEAR BIRMINGHAM

Manufacturers of Specially Prepared Red Lead for Flint-Glass Making.

CHEMICAL & PHYSICAL APPARATUS,
BOTTLES, PURE CHEMICALS,
REAGENTS, STANDARD SOLUTIONS,
And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

MOTTERSHEAD & CO.,
7, Exchange Street and 10, Half Moon Street,
MANCHESTER.

DAHL & CO.,
BARMEN (RHENISH PRUSSIA),
MANUFACTURERS OF
ANILINE AND NAPHTHALINE COLOURS.
SPECIALITY—Ponceau Naphthol-Reds as a Substitute for Cochineal.
Sole Agency and Depôt in England,
THEODOR BANG,
BENSON'S BUILDINGS, BASINGHALL ST., LEEDS.

THE CHEMICAL NEWS.

VOL. XLI. No. 1066.

SOME ELECTRICAL MEASUREMENTS OF ONE OF MR. EDISON'S HORSESHOE LAMPS.

By HENRY MORTON, Ph.D., ALFRED M. MAYER, Ph.D., and B. F. THOMAS, A.M., at the Stevens Institute of Technology.

THE lamp with which the following measurements were made is one of the carbonised paper horseshoe pattern of recent construction, marked No. 154, and kindly loaned to the present writers by the *Scientific American*.

The first object, on receiving the lamp, was to determine roughly what amount and character of electric current would be needed to operate it efficiently. With this view a number of cells of a small Grove's battery were set up, having each an active zinc surface of 20 square inches and a platinum surface of 18 square inches.

The lamp being placed in the situation usually occupied by the standard burner in a Sugg's photometer, the battery was, cell by cell, thrown into circuit.

When 10 cells had been introduced the horseshoe showed a dull red; with 15 cells, a bright red; with 34 cells the light of 1 candle was given; with 40 cells the light of 4½ candles, and with 45 cells the light of 9⅓ candles, and with 48 cells, 16 candles.

Having thus determined what amount of electric current would be required for experiments, arrangements were made to measure accurately the resistance of the horseshoe while in actual use and emitting different amounts of light. The resistance of this carbon thread at the ordinary temperature had been already determined as 123 ohms in the usual way, but it was presumed, as had been shown by Matthiessen (*Phil. Mag.*, xvi., 1858, pp. 220, 221), that this resistance would diminish with rise of temperature.

To measure the resistance under these circumstances the apparatus was arranged as follows:—The current from the battery was divided in two branches, which traversed, in opposite directions, the two equal coils of a differential galvanometer. One branch then traversed the lamp, while the other passed through a set of adjustable resistances composed of German-silver wires stretched in the free air of the laboratory, to avoid heating. (Careful tests of these resistances showed that no sensible heating occurred under these circumstances.)

Matters being thus arranged, the resistances were adjusted until the galvanometer showed no deflection, when the candle power of the lamp was taken repeatedly in the photometer, and the amount of resistance was noted.

These measurements were several times repeated, shifting the coils of the galvanometer and reversing the direction of the current.

The results so obtained were as follows:—

Resistances.	Condition of Loop.
123 ohms	Cold
94 „	Orange light
83·7 „	$\frac{1}{10}$ candle
79·8 „	5 „
75 „	18 „

The photometric measurement was in all these cases taken with the carbon loop at right angles to the axis of the photometer, which was, of course, much in favour of the electric lamp. On turning the lamp round so as to bring the carbon loop with its plane parallel with the axis of the photometer, *i.e.*, the edge of the loop turned toward the photometer disk, the light was greatly diminished, so that it was reduced to one-third of what it was with the loop sideways to the photometer disk.

Having thus determined the resistance of the lamp when in actual use, it was next desirable to measure the quantity of the current flowing under the same conditions.

To do this the current from fifty cells of battery was passed through a tangent galvanometer as a mere check or indicator of variations, and then through a copper voltameter, *i.e.*, a jar containing solution of cupric sulphates with copper electrodes immersed, and then through the lamp, placed in the photometer.

Under these conditions it was found that during an hour the light gradually varied from about 16 candles at the beginning to about 14 candles at the end, making an average of about 15 candles, measured with side of loop toward disk.

The galvanometer during this time only showed a fall of half a degree in the deflection of the needle.

Carefully drying and weighing the copper electrodes, it was found that one had gained 1·0624 grms.

Now, it is well known that a current of one weber deposits 0·00326 grm. of copper per second, which would make 1·1736 grms. in an hour; therefore the current in the present case must have been on the average—

$$\frac{1{\cdot}0624}{1{\cdot}1736} = 0{\cdot}905 \text{ webers},$$

or a little less than one weber.

Having thus obtained the resistance of the lamp when emitting a light of 15 candles, namely, 76 ohms, and the amount of current passing under the same conditions, namely, 0·905 weber, we have all the experimental data required for the determination of the energy transformed or expended in the lamp, expressed in foot-pounds. For this we multiply together the square of the current, the resistance, the constant 0·737335 (which expresses the fraction of a foot-pound involved in a current of one weber traversing a resistance of one ohm for one second), and the number of seconds in a minute. Thus, in the present case, we have $0{\cdot}905^2 = 0{\cdot}8125$, and—

$$0{\cdot}8125 \times 76 \times 0{\cdot}737335 \times 60 = 2753{\cdot}76 \text{ foot-pounds.}$$

Dividing these foot-pounds per minute by the number of foot-pounds per minute in a horse power, that is, 33,000, we have 0·08, that is, about eight one-hundredths or one-twelfth of a horse power as the energy expended in each lamp.

It would thus appear that with such lamps as this, one horse-power of energy in the current would operate 12 lamps of the same resistance with an average candle-power of 10 candles each,* or 120 candles in the aggregate.

Assuming that a Siemens or Brush machine were employed to generate the electric current, such a current would be obtained, as has been shown by numerous experiments, with a loss of about 40 per cent of the mechanical energy applied to the driving pulley of the machine. To operate these 12 lamps, therefore, we should have to apply more than one horse-power to the pulley of the machine, so that when this loss in transformation had been encountered there should be one horse-power of electric energy produced. This would call for 1⅔ horse-power applied to the pulley of the dynamo-electric machine by the steam-engine.

To produce one horse-power in a steam-engine of the best construction about 3 lbs. of coal per hour must be burned, and therefore for one and two-thirds horse-power 5 lbs. of coal must be burned.

On the other hand, 1 lb. of gas coal will produce 5 cubic feet of gas, and will leave, besides, a large part of its weight in coke, to say nothing of other "residuals," which will represent practically about the difference in value between "steam-making" and "gas-making coal,"

* This average was determined in the following manner:—The lamp was attached to a horizontal divided circle at its base, and being placed in the photometer its light was then measured at various azimuths, differing by 10° from 0° to 180°. The various quantities so found were added and divided by the number of terms, and it was thus shown that the actual average light emission was the arithmetical mean of the extremes, which were 15 candles and 5 candles respectively. This result was not anticipated, but it so came out on two repetitions of the measurements.

so that it will not be unfair to take 5 lbs. of gas coal as the equivalent of 5 lbs. of steam coal.

These 5 lbs. of gas coal will then yield 25 cubic feet of gas, which, if burned in five gas-burners of the best construction, will give from 20 to 22 candles each, or 100 to 110 candles in the aggregate.

We have, then, the twelve Edison lamps producing 120 candles, and the five gas-burners producing 100 to 110 candles, with an equivalent expenditure of fuel.

If each apparatus and system could be worked with equal facility and economy, this would of course show *something* in favour of the electric light; but when in fact everything in this regard is against the electric light, which demands vastly more machinery, and that of a more delicate kind, requires more skillful management, shows more liability to disarrangement and waste, and presents an utter lack of the storage capacity which secures such a vast efficiency, convenience, and economy in gas, then we see that this relatively trifling economy disappears or ceases to have any controlling importance in the practical relations of the subject.

ON THE

EFFICIENCY OF EDISON'S ELECTRIC LIGHT.

By Prof. H. A. ROWLAND, of the Johns Hopkins Uuniversity, and Prof. GEORGE F. BARKER, of the University of Pennsylvania.

THE great interest which is now being felt throughout the civilised world is the success of the various attempts to light houses by electricity, together with the contradictory statements made with respect to Mr. Edison's method, have induced us to attempt a brief examination of the efficiency of his light. We deemed this the more important because most of the information on the subject has not been given to the public in a trustworthy form. We have endeavoured to make a brief but conclusive test of the efficiency of the light, that is, the amount of light which could be obtained from one horse-power of work given out by the steam engine. For if the light be economical, the minor points, such as making the carbon strips last, can undoubtedly be put into practical shape.

Three methods of testing the efficiency presented themselves to us. The first was by means of measuring the horse-power required to drive the machine, together with the number of lights which it would give. But the dynamometer was not in very good working order, and it was difficult to determine the number of lights and their photometric power, as they were scattered throughout a long distance, and so this method was abandoned. Another method was by measuring the resistance of, and amount of current passing through a single lamp. But the instruments available for this purpose were very rough, and so this method was abandoned for the third one. This method consisted in putting the lamp under water and observing the total amount of heat generated in the water per minute. For this purpose, a calorimeter, holding about 1¾ kil. of water, was made out of very thin copper: the lamp was held firmly in the centre, so that a stirrer could work around it. The temperature was noted on a delicate Baudin thermometer graduated to 0·1° C.

As the experiment was only meant to give a rough idea of the efficiency within two or three per cent, no correction was made for radiation, but the error was avoided as much as possible by having the mean temperature of the calorimeter as near that of the air as possible, and the rise of temperature small. The error would then be much less than one per cent. A small portion of the light escaped through the apertures in the cover, but the amount of energy must have been very minute.

In order to obtain the amount of light and eliminate all changes of the engine and machine, two lamps of nearly equal power were generally used, one being in the calorimeter while the other was being measured. They were then reversed and the mean of the results taken. The apparatus for measuring the light was one of the ordinary Bunsen instruments used for determining gas-lights, with a single candle at ten inches distance. The candles used were the ordinary standards burning 120 grains per hour. They were weighed before and after each experiment, but as the amount burned did not vary more than one per cent from 120 grains per hour, no correction was made.

As the strips of carbonised paper were flat, very much more light was given out in a direction perpendicular to the surface than in the plane of the edge. Two observations were taken of the photometric power, one in a direction perpendicular to the paper, and the other in the direction of the edge, and we are required to obtain the average light from these. If L is the photometric power perpendicular to the paper, and l that of the edge, then the average λ will evidently be very nearly—

$$\lambda = L\int_{\frac{1}{2}\pi}^{0} \cos\alpha \sin\alpha \, d\alpha + l\int_{\frac{1}{2}\pi}^{0} \sin^2\alpha \, d\alpha$$

$$\lambda = \tfrac{1}{4}L + \frac{\pi}{4} l$$

In the paper lamps we found $l = \frac{1}{3}L$ nearly; hence $\lambda = \frac{2}{3}L$ nearly.

The lamps used were as follows:—

No.	Kind of Carbon.	Size of Carbon.	Approximate resistance when cold.
580	Paper	Large	147 ohms.
201	,,	,,	147 ,,
850	,,	Small	170 ,,
809	,,	,,	154 ,,
817	Fibre	Large	87 ,,

The capacity of the calorimeter was obtained by adding to the capacity of the water the copper of the calorimeter and the glass of the lamp and thermometer. The calorimeter and cover weighed 0·103 kil., and the lamps about 0·035 kil.

First experiment, No. 201 in calorimeter and No. 580 in photometer; capacity of calorimeter = 1·153 + 0·009 + 0·007 = 1·169 kil. The temperature rose from 18·28° C. to 23·11° C. in five minutes, or 1·75° F. in one minute. Taking the mechanical equivalent as 775·0, which is about right for the degrees of this thermometer, this corresponds to an expenditure of 3486 foot-pounds per minute. The photometric power of No. 580 was 17·5 candles maximum, or 13·1 mean, λ.

When the lamps were reversed, the result was 3540 foot-pounds for No. 580, and a power of 13·5, or 10·1 candles mean.

Lamps used in Calorimeter.	Lamps used in Photometer.	Photometric Power Measured perpendicular to paper L.	Photometric Power Average, λ.	Capacity of Calorimeter in pounds.	Rise of temperature in degrees F.	Energy per minute in foot-pounds.	Mean number of candles per horse-power of electricity.	Mean number gas jets of 16 candles each per h-p. of Electricity.	Mean number of gas-jets per indicated horse-power.
201	580	17·5	13·1	2·57	1·75°	3486·0	109·0	6·8	4·8
580	201	13·5	10·1	2·82	1·62°	3540·0			
580	201	38·5	28·9	2·74	2·41°	5181·0	204·3	12·8	8·9
201	580	44·6	33·5	2·76	2·29°	4898·0			
850	809	19·0	14·3	2·81	1·14°	2483·0	133·4	8·3	5·8
809	850	12·2	9·2	2·79	1·54°	3330·0			
817			17·2	2·73	1·28°	2708·0	209·6	13·1	9·2

The mean of these two gives, therefore, a power of 3513 foot-pounds per minute for 11·6 candles, or 109·0 candles to the horse-power.

To test the change of efficiency when the temperature varied, we tried another experiment with the same pair of lamps, and also used some others where the radiating area was smaller, and, consequently, the temperature had to be higher to give out an equal light.

We combine the results in the following table, having calculated the number of candles per indicated horse-power by taking 70 per cent of the calculated value, thus allowing about 30 per cent for the friction of the engine, and the loss of energy in the magneto-electric machine, heating of wires, &c. As Mr. Edison's machine is undoubtedly one of the most efficient now made, it is believed that this estimate will be found practically correct. The experiment on No. 817 was made by observing the photometric power before and after the calorimeter experiment, as two equal lamps could not be found. As the fibre was round it gave a nearly equal light in all directions, as was found by experiment.

The increased efficiency, with rise of temperature, is clearly shown by the table, and there is no reason, provided the carbons can be made to stand, why the number of candles per horse-power might not be greatly increased, seeing that the amount which can be obtained from the arc is from 1000 to 1500 candles per horse-power. Provided the lamp can be made either cheap enough or durable enough, there is no reasonable doubt of the practical success of the light, but this point will evidently require much further experiment before the light can be pronounced practicable.

In conclusion, we must thank Mr. Edison for placing his entire establishment at our disposal in order that we might form a just and unbiassed estimate of the economy of his light.—*American Journal of Science*, vol. xix., April, 1880.

ON THE CONDITION IN WHICH SULPHUR EXISTS IN COAL.

By Dr. W. WALLACE, Glasgow.

It has been assumed that sulphur exists in coal chiefly, if not exclusively, in the form of bisulphide of iron, the presence of which can be detected in almost all varieties of the mineral. Crace-Calvert asserted many years ago that in some cases, at least, sulphur existed in coal in the form of a sulphate, and he gave a process for the estimation of the sulphur existing in this form. Some analyses which I have recently made have shown conclusively, however, that in some coals the greater part of the sulphur exists as an organic compound. These coals contain but a small proportion of iron—not nearly enough to form bisulphide with the iron that exists in them—and one well known description known as the Ell coal was found not to contain a trace of sulphuric acid when tested by Crace-Calvert's method. The others were not tested.

The following table shows the relative quantities of total sulphur and that existing as pyrites, as calculated from the iron found in the ash of the coal, assuming that all the iron exists as bisulphide, which is not always the case, as some coals contain carbonate of iron.

	Total Sulphur.	S. as Bisulphide.
Ell coal (Lanarkshire)	0·91	0·11
Main coal ,, ...	0·60	0·42
Splint ,, ...	0·46	0·14
Pyotshan ,, ...	0·68	0·17
Soft coal from Fife	0·93	0·49

The estimations of sulphur were made by Pattinson's method, and also by fusion with sodic carbonate and potassic nitrate. When carefully performed and blank experiments made to eradicate sources of error, these methods give concordant results. It is well known that boiling with nitric acid does not give the whole of the sulphur, and I find that the amount obtained usually corresponds closely with that existing as pyrites.

The following analyses of the coals referred to may be useful for comparison with English varieties, of which the composition is given in several works on chemical technology.

	Ell.	Main.	Splint.	Pyotshan.	Fife.
Carbon	71·37	67·35	70·05	72·21	61·88
Hydrogen ..	5·13	5·03	5·24	4·79	4·89
Oxygen	8·88	12·66	12·37	9·77	12·78
Nitrogen	1·44	1·40	1·36	1·51	1·14
Sulphur	0·91	0·60	0·46	0·68	0·93
Ash	0·91	3·60	3·80	2·74	3·92
Water at 100° C.	11·36	9·36	6·72	8·30	14·46
	100·00	100·00	100·00	100·00	100·00
Spec. grav. ..	1·255	1·293	1·282	1·280	1·250
Heat units, C...	7190	6628	6929	7062	6132
,, F...	12,942	11,932	12,472	12,711	11,037
Lbs. of water evapd. by 1 lb. of coal (theoretical)—	13·20	12·18	12·74	13·00	11·21

In calculating the last figure allowance has been made for the evaporation of the water contained in the coal. Some authorities give the results of analyses of coals in the dried state, but such statements are of little practical value and are apt to mislead consumers of fuel. The water in coal, although readily expelled by heat, varies very little in samples taken from the pit at different times, and, in fact, is as constant as the composition of the coal itself, which varies sensibly in different portions of the field.

THE ATOMIC WEIGHT OF ANTIMONY.

PRELIMINARY NOTICE OF ADDITIONAL EXPERIMENTS.*

By JOSIAH P. COOKE.
Erving Professor of Chemistry and Mineralogy.

In our previous paper on this subject,† we gave our reasons for the opinion, since fully confirmed, that the bromide of antimony is the most suitable compound of this element as yet known for determining its atomic weight; and the results of fifteen analyses of five different preparations of the bromide were published, which gave for the atomic weight in question the mean value 120·00 with an extreme variation between 119·4 and 120·4 for all the fifteen analyses, and between 119·6 and 120·3 for the six determinations in which we placed most confidence. The antimonious bromide used in these determinations was purified first by fractional distillation, and secondly by crystallisation from a solution in sulphide of carbon. In the crystallised product thus obtained, the bromine was determined gravimetrically as bromide of silver in the usual way. Although it seemed at the time that the results were as accordant as the analytical process would yield under the unfavourable conditions, which the presence of a large amount of tartaric acid in the solution of the bromide of antimony necessarily involved; yet it was obvious that the agreement was far from that which was desirable in the determination of an atomic weight, and our chief confidence in the accuracy of the mean value—independently of its remarkable agreement with previous results—was based on the fact that the known sources of error tended to balance each other. Hence our conclusions were stated with great caution, and the hope was

* Contributions from the Chemical Laboratory of Harvard College. Presented to the American Academy of Arts of Sciences, March 10, 1880.

† *Proceedings of the American Academy of Arts and Sciences*, vol. xii., p. 1.

expressed that after a more thorough investigation of the subject we might be able "to return to the problem with such definite knowledge of the relations involved as will enable us to obtain at once more sharp and decisive results than are now possible." Unfortunately this investigation has been delayed by causes beyond our control.

In our previous paper we described a simple apparatus which we devised for subliming iodide of antimony; and in a note to the paper we stated that we were applying the same process to the preparation of the bromide of antimony, and that it promised excellent results. Our expectations in this respect have been fully realised, and the product leaves nothing to be desired either as regards the beauty or the constancy of the preparation. The fine acicular crystals are perfectly colourless, and have a most brilliant silky lustre. With ordinary precautions they can be kept indefinitely without change, and it is easy therefore to determine the weight of the material analysed to the tenth of a milligramme.

We have carefully studied the causes of error involved in the analytical process of determining bromine in an aqueous solution of bromide of antimony and tartaric acid by the usual gravimetric method. These causes we propose to discuss in a future more extended paper. In this preliminary notice, we have only space to state that we have satisfied ourselves that the small differences between the results previously obtained arose wholly from the analytical process, and not from any want of constancy in the material analysed; and further that these sources of error are to a very great extent under control. Moreover, we have found that the volumetric determination of bromine by silver was not materially affected, if at all, by the same causes. We have thus been led to devise a mode of testing the atomic weight of antimony, which, while it has all the advantages of the gravimetric method previously employed, is free from its sources of error.

If the atomic weight of antimony were 122·00, it would require 1·7900 grms. of pure silver to precipitate the bromine from a solution of 2·0000 grms. of antimony bromide, while if the atomic weight of antimony were 120·00 it would require 1·8000 grms. of silver. Now it is easy to estimate volumetrically 1-100th of this difference with great certainty. We therefore prepared with great care a button of *pure* metallic silver, which we annealed and rolled out to a thin ribbon. We then weighed out from 2 to 4 grms. of bromide of antimony, prepared by sublimation as described above, and dissolved this salt in an aqueous solution of tartaric acid, which we then transferred to a litre flask and diluted to about 500 c.c. We next very accurately weighed out a quantity of silver slightly less than that which calculation showed was required for complete precipitation. This silver was dissolved in nitric acid, and the solution having been evaporated to dryness over a water-bath, the silver salt was washed into the flask containing the bromide of antimony. As soon as the supernatant liquid had cleared, the small additional amount of a normal silver solution required to produce complete precipitation was run in from a burette, and measured with the usual precautions. We used no extraneous indicator, because it was important not to introduce any possibly new disturbing element into the experiment, and in the titration of bromine with silver the normal and familiar phenomena, which mark the close of the process, furnish a very sharp indication. The details of one of the determinations were as follows:—

The weight of the bromide of antimony used amounted to 2·5032 grms. To precipitate the bromine from the solution of this material 2·2404 grms. of silver would be required if Sb = 122·00 and 2·2529 if Sb = 120·00. We weighed out, with as much accuracy as if we were adjusting a weight, the smaller of these two quantities of metallic silver, and after dissolving the pure metal in pure nitric acid, evaporating the solution to dryness, and redissolving in water, we added at once the whole of this silver solution to the litre flask containing the solution of bromide of antimony, in the manner described above. It was then found that $12\frac{4}{10}$ c.c. of a normal silver solution (1 grm. of silver to the litre) were required to complete the precipitation. It will be seen that the weights of the bromide of antimony and silver used could be thus determined with the most absolute precision, and we have the greatest confidence in these values to the one-tenth of a milligramme. Moreover, it will be noticed that the volumetric method is only used to estimate the difference in the atomic weight which has been in question, and that if the method were only accurate to the one-tenth of the quantity to be measured it would give us the value of the atomic weight within two-tenths of a unit; while if, as we had reason to believe, the process was accurate within 1 per cent, it would fix the atomic weight within two-hundredths of a unit.

By the method just described, the following results were obtained. The letters *a* and *b* indicate different preparations.

	Wt. of $SbBr_3$ taken.	Total Wt. of Ag used.	Per cent of Br, Ag=108, Br=80.	Corresponding value of Sb.
(*a*) 1.	2·5032	2·2528	66·6643	120·01
(*a*) 2.	2·0567	1·8509	66·6620	120·02
(*a*) 3.	2 6512	2·3860	66·6644	120·01
(*b*) 4.	3·3053	2·9749	66·6696	119·98
(*b*) 5.	2·7495	2·4745	66·6653	120·01
Mean value			66 6651	120·01
Mean value of 15 gravimetric determinations previously published			66·6665	
Theory Sb 120 requires			66·6666	
„ Sb 122 „			66·2983	

In order still further to control the work, we collected the bromide of silver formed in the last two determinations, washing the precipitate with the precautions which experience had shown to be necessary, and determining its weight, first, after drying at 150° C., and, secondly, after heating to incipient fusion. In *b* 6 there was a loss of one-tenth of a milligramme; in *b* 7 a loss of two-tenths of a milligramme only at the second weighing. This is an absolute proof that there could be no sensible occlusion of any tartaric acid or any tartrate by these precipitates, and, as stated in our original paper, the same test was frequently applied, although not always, in our previous determinations. It is also evident that these last experiments give us two essentially distinct determinations of the atomic weight, although the materials employed were identical with those of *b* 4 and *b* 5.

	Wt. of $SbBr_3$ taken.	Wt. of AgBr determined.	Per cent of Br, Ag=108, Br=80.	Corresponding value of Sb.
(*b*) 6.	3·3053	5·1782	66·665	120·01
(*b*) 7.	2·7495	4·3076	66·667	120·00
Mean value..			66·666	120·00

Lastly, it is obvious that these gravimetric determinations, taken in connection with the corresponding volumetric results, give us the most conclusive evidence of the purity, both of the metallic silver used, and also of the bromide in the bromide of antimony, which is the basis of this atomic weight investigation. By comparing *b* 6 and *b* 7 with *b* 4 and *b* 5 respectively, we obtain the following data:—

1. 2·9749 grm. of silver gave 5·1782 grm. bromide of silver.
2. 2·4745 „ „ „ 4·3076 „ „ „

Hence it follows that, as shown by these experiments, the proportions of the silver to the bromine were respectively:—

1.	108·00	silver to 79·99	bromine.
2.	108·00	„ 80·01	„
Mean value,	108·00	„ 80·00	„

This is the ratio of the atomic weight of silver to that of bromine, and corresponds to the second decimal place

with the determinations of Stas as well as with those of Dumas.

In conclusion it gives us pleasure to express our obligations to Mr. G. De N. Hough and Mr. G. M. Hyams, two students of this laboratory, who have greatly aided us in the experimental work of this investigation.—*Proceedings of the American Academy of Arts and Sciences.*

A NEW METHOD OF TAKING THE SPECIFIC GRAVITY OF LIQUIDS.

By H. SOMMERKORN.

THE apparatus required is a thin-sided glass tube, divided into millimetres, and of from 3 to 4 centimetres in diameter, and a thin circular plate of exactly the same diameter, held by a string. The tube is closed with the plate, and the apparatus plunged into the liquid to be examined, pulling the plate against the tube with the thread. If the tube is plunged deep enough the hydrostatic pressure causes the plate to adhere. If the tube is then slowly raised upwards in a vertical position, we reach a point where it merely hovers, and at the next it sinks. This point is easily observed. In the same moment the depth to which the tube is immersed in the liquid is read off on the scale.

If the specific gravity of the liquid = s, the superficies of the plate of glass or platinum = a, and its weight = G, and the depth to which the tube was immersed in the liquid = h. At the moment when the plate is about to sink its weight, G, must be equal to the weight of a column of liquid of the height, h, the area, a, and the specific gravity s, or a, h, s, which pressure, being equal to the weight of the plate,—

$$s = \frac{G}{a.h}.$$

The factor $\frac{G}{a}$ is the same for all measurements, h only being a variable quantity.

ON THE HISTORY OF ATOMISTIC PERIODICITY.

By LOTHAR MEYER.

THE author is induced to refer to the origin of the doctrine of the periodicity of atomic weights in order that his share in the matter may not be forgotten. As long as the so-called equivalent weights of Gmelin were made use of a universal periodicity could not be detected. After Cannizzaro had established the correct principles for the determination of atomic weights, the regularities which had been observed up to that time took shape in the first edition of my "Modern Theories," in 1864.

A candid scrutiny there will be found in these tables, something more than a "simple collocation of groups of analogous elements"—namely, the endeavour to arrange bodies according to the magnitude of their atomic weights, and to show that chemical value varies regularly in accordance with atomic weight. Only the group Cu, Ag, Au was placed at the end of the second table because it contained elements of unequal value, concerning which I then doubted whether they belonged together. Otherwise the two tables contained about the half of what we now regard as the natural system of the elements. It likewise did not escape my notice that the second table with the group Zn, Cd, Hg could be joined to the left side of the first, and thus united with it to form a whole. In consequence of this observation I attempted to introduce all the other elements into the table. I could not succeed, as I was misled by the erroneous atomic weights, Mo = 92, Nb = 97·6, Vd = 137, Ta = 136·6, instead of Mo = 96, Nb = 94, Vd = 51, Ta = 182. After these errors were corrected I had no difficulty in inserting all the elements in a single table arranged according to the magnitude of the atomic weights.

Before I made this public there appeared in the *Zeit. fur Chemie* (New Series, vol. v., p. 405) an extract from a memoir by Prof. Mendelejeff containing a tabular arrangement of the elements. In the text accompanying the table it was remarked that the elements, when arranged according to the magnitude of their atomic weights show a serial modification of their properties; that the atomic weights determine these properties; that some atomic weights require correction; and that the discovery of new elements was to be foreseen, besides other less important observations. These points of view were published by Prof. Mendelejeff earlier than by me, and probably than by anyone, unless the claims of priority of Mr. Newlands —which I have hitherto been unable to examine—should be justified.

We see at the same time that Prof. Mendelejeff's table does not contain a single series advancing according to the magnitude of the atomic weights, but three series, which cannot be connected together and are very unequal in length. This is the more striking, as such discontinuity was produced merely by the introduction of seven uncertain, and, as we now know, inaccurately, determined atomic weights (Er, Y, In, Ce, La, Di, Th). If Mendelejeff had then laid any weight upon the establishment of a single series he would doubtless have assumed these weights differently.

My treatise, "The Nature of the Chemical Elements as a Function of their Atomic Weights" (*Ann. Chem. Pharm.*, 7, Supplement, p. 354), which was written in December, 1879, and published soon after, contained the first conspectus of all the atomic weights then accurately known arranged in a single series, that of indium being corrected in accordance with the periodic law, as was soon afterwards confirmed by Bunsen.

This arrangement is derived from a completion of my former attempt, from which it is externally distinguished merely by the circumstance that the successive atomic weights are not placed horizontally, but, as is done by Mendelejeff, vertically. It is distinguished from the tables of this chemist by the removal of the inaccurate atomic weights above mentioned. I showed, at the same time, by occasion of my graphic representation of the atomic volumes, that these elements which I had introduced possess only a part of the properties of the elements to which they were placed as corresponding so that certain properties do not recur before the next period but one, and the periodicity must be regarded as twofold. Prof. Mendelejeff subsequently, without making mention of me, utilised this fact as the distinction between his "even" and "odd" series.

Prof. Mendelejeff has, in his justly celebrated memoir, "The Periodic Regularity of the Chemical Elements," adopted as correct all that I had added to his work, but without the least mention of my researches. He gives a second table, which resembles mine much more closely than did his first, only that, like my first, the series are arranged horizontally. He introduced a number of new and weighty considerations which greatly extend our knowledge of the subject. I include here, above all, the introduction of the chemical value of the elements as determined from the composition of their non-volatile compounds, especially the oxides, and the no less bold than fortunate prediction of the properties o undiscovered elements such as gallium and scandium.—*Berichte der Deutschen Chemischen Gesellschaft.*

Behaviour of Phenanthren-quinon with Ammonia. —E. v. Sommaruga.—The reaction is not the same as in the case of isatin, and the number of the products is much greater. Among the compounds obtained and described are diphenanthren-oxytriimide and isodiphenanthren-oxytriimide.—*Wiener Anzeiger*, 1880, 20.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Ordinary Meeting, April 24, 1880.

Prof. W. G. Adams in the Chair.

New members:—The Marquis of Blandford, Mr. J. Marshall.

Prof. G. C. Foster read a note by Prof. Rowland, of Baltimore, U.S., on the discovery of Mr. Hall that a magnet exercises an electromotive force on a current in a conductor crossing its field, as well as a force on the conductor itself. This fact will render it necessary to apply a correction to equations which assume that only the latter force acts. The electromotive force in question is at right angles to the direction of the current and to the lines of magnetic force. Prof. Rowland expresses it mathematically in this note, and bases a new method of determining the value of v, the ratio of the electrostatic to the electromagnetic unit of electricity, which gives v almost identical with the velocity of light, thus confirming Clerk-Maxwell's theory of the nature of light.

Dr. J. Hopkinson, F.R.S., suggested an expression for one of Prof. Rowland's results.

Prof. Foster also read a note by Prof. Wild, of the Central Russian Meteorological Observatory, on a mode of correcting the bifilar magnetometer for torsion of its fibres, &c., and a method for finding the horizontal component of the earthy magnetism by its aid.

Mr. Ridout, F.C.S., described an improved thermo-electric apparatus of his construction. The author has followed the idea of combining the thermo-pile, and galvanometer in one instrument on the same base-board. The defects of the apparatus as ordinarily made are a too great disparity between the resistance in the pile and in the galvanometer; the junctions of the pile are too deep, and short circuit the current; the bars too long and resisting, as well as too numerous; the junctions too slender; the mass of matter to be heated too great. These defects are remedied by placing the bars in glass tubes connected with thin plates of copper, making the bars half the usual length and using only a single pair. The defects in the galvanometer are that the wire does not come near the needle; the needles are not of the best form; and the suspension is troublesome. Mr. Ridout makes the wire a flat ribbon mounted on one bobbin; the needles are flat oblong plates from the same piece of steel and magnetised in one piece; they are mounted on a pivot turning in an agate cup. The several parts of the apparatus are mutually adapted to each other; and in using it the galvanometer is not joined to the pile till the latter has been exposed to the heat, so as to prevent the current generated abstracting heat from the hot side. As made by Mr. Browning the pile consists of a pair of elements $\frac{1}{2}$ in. long, the copper connections being circular plates $\frac{1}{100}$ in. thick, and $\frac{5}{8}$ in. diameter. The pile is supported by thick copper terminals above the galvanometer, which consists of a copper ribbon, making some 20 turns round a pair of astatic needles, 1 in. long and $\frac{1}{8}$ in. broad, pivotted in an agate cup. A contact key, placed on one side, and the whole is enclosed in a glass shade perforated opposite the pile. A glass cone protects the front from extraneous heat, and a glass case the back. A directing magnet is fixed above the pile. Contact between the galvanometer and pile is made after, say, 30 secs. exposure to the heat. The pile is affected by a person standing 6 feet from it, and the radiation from stellar space is evident in clear weather. Half a minute is sufficient to put the instrument ready for use.

Mr. Ridout also exhibited laboratory experiments, showing cohesion in mercury by causing it to overflow up an inclined trough; electrolysis of water by a single Grove or bichromate cell through diminishing the pressure in the flask containing the water by boiling it and condensing the vapour on cooling; a differential thermometer showing absorption of heat on liquefying solids; and the production of musical notes in glass tubes by contracting the bore smoothly to about one-fourth of the diameter at one part.

Prof. Foster remarked that the cohesion experiment might show the surface tension.

Prof. Guthrie and Prof. Hughes offered remarks on the electrolytic experiment, the latter stating that he finds the resistance of an iron cell he has constructed to depend on the electrodes rather than the liquid; when the negative plate is tempered iron the resistance is low, when soft iron it is high.

Prof. Stone exhibited photographs of König's new tonometer, described by him at the last meeting, and further mentioned that König had devised a thermometer based on the principle that changes of temperature produce corresponding changes in the vibration-rate of a tuning-fork. The temperature is formed from the rate of the fork by bringing it to a zero rate by means of a rider.

Prof. Michin then described his experiments to solve the problem of transmitting light by photo-electric action. Two years ago he conceived the idea of employing for this purpose the fact that light falling on a sensitised silver plate disengages electricity. He forms a sensitive cell composed of two silver plates immersed in a conducting solution; one plate is coated with a sensitive emulsion of chloride or bromide of silver. When chloride is used a solution of salt in water forms the liquid, when bromide a solution of bromide of potash. A current is set up in this cell even in the dark, but when exposed to the magnesium light the current is very powerful, and flows within the cell from the uncoated to the sensitised plate. Prof. Michin also conducted this current toy wire to a second cell in a dark chamber, and found that it effected a decomposition of the sensitive plate in that cell, as shown by a distinct darkening of the plate when "developed" by pyrogallic acid. The same effect was produced whether the current was reversed or not. Prof. Michin is continuing his experiments, and has provided a cable containing a number of separate conductors, insulated from each other, in order to convey the currents from several cells.

Prof. Perry feared that the effect would not be strong enough; but

Prof. Michin said the light of a match produced a decided photo-electric effect in the cell.

Prof. Perry alluded to the selenium plan proposed by himself and Prof. Ayrton, and said that Mr. Willoughby Smith had observed selenium to be sensitive to the shadow of a flying swallow.

Prof. Adams testified to the sensitiveness of selenium, and its power of being directly excited by light, a fact first proved by the experiments of Mr. Day and himself.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, January 13, 1880.

J. P. Joule, D.C.L., LL.D., F.R.S., &c., President, in the Chair.

"*The Radiograph*," by D. Winstanley, F.R.A.S. I have desribed already one of the several arrangements which I have devised for the automatic registration of the solar radiance.* The instrument in question places a lead pencil on a sheet of paper and writes down therewith when, and for how long, the sun may chance to shine, but it makes no record of the intensity of his rays. I will now ask your attention to the description of another and much more perfect apparatus, one which continuously

* Proceedings of Manchester Lit. and Phil. Soc., November 18th, 1879.

records the intensity of thermal radiation to which it is exposed. This instrument I have called the "Radiograph." It consists essentially as follows :—A differential thermometer of which the stem is circularly curved is mounted concentrically upon a wheel of brass in a groove cut with that object for its end. This wheel is supported with its plane in a perpendicular position by a knife edge of hardened steel which passes through its geometric centre and rests on agate planes. The tube of the thermometer is partly filled with mercury—preferably through half its curve—and for the reason given in my description of the simple sunshine recorder, to which I have alluded, a little sulphuric acid is introduced as well. If we now arrange it that the centre of gravity of the solid portion of the system here described shall be below the surface of the planes on which it turns (and the apparatus is provided with adjustments by means of which the point in question can be moved) it is clear that the arrangement may be made to swing in pendulous oscillations, notwithstanding the presence of the liquids it contains, for these remain substantially at rest whilst the tube which holds them does, in fact, slide over them (and with very little friction too) in swinging to and fro through arcs of the circles of which its parts are curves. Both bulbs of the thermometer are closed. It is obvious, therefore, that the tension of the air or gas which they contain will be uninfluenced by the barometric variations of the outer air, the temperature of which lattter being experienced equally in each bulb will also leave the equilibrium of the apparatus undisturbed. When, however, one bulb is more heated than the other, the air contained therein will press more strongly on the heavy liquid piston in the tube and wheel the swinging portion of the system round until a fresh position of equilibrium is gained, and this will be (providing that the centre of gravity of the system has previously been made coincident with the point on which it turns) when the tension of the gases is equal in both bulbs. In fact, in so far as now described, the instrument is a differential thermometer, and is that alone, differing in this from Leslie's, that it is a solid and accessible portion of the thing which moves, and not the liquid it contains. When, however, one of the bulbs is blacked and the other one is silvered or left clear, the apparatus becomes a "Radiometer" in the proper meaning of the term, that is to say, a measurer of the thermal radiance to which it is exposed and the intensity of which it indicates by variations in the angular positions of a needle prolonged from one or other of the radii of the wheel.

It is only needful now to so arrange it that this needle shall make a tracing of its curves on a cylinder driven by clockwork at an even speed, and the "Radiograph" is complete.

Concerning the actual instrument I use, its wheel is 7·3 inches in diameter, and the weight thereof a trifle more than two pounds. The other portions of the apparatus are of the same dimensional proportions as are indicated in the sketch. Of course some delicate method of recording has to be employed, and I have thus far used the smoked paper process so much adopted in the observatories of France. In this way the "Radiograms" which illustrate this paper were obtained.

When using the instrument to record the radiance of the sun I have hitherto exposed it in a box of copper surmounted by a dome of glass into which the bulbs of the thermometer project. The line which joins them is in the plane of the meridian of the place and the black bulb to the north. The box itself is supported at an elevation of four feet or thereabouts upon a stand of wood, the legs of which are firmly embedded in the ground. The stand itself is located at the extremity of a garden which overlooks a valley and the sea. A small window in the box permits the movements of the train to be seen and the promptness with which the apparatus acts to be observed. If a cloud "no bigger than a man's hand," and "light as a feather" in its texture, floats before the sun, and occupies but three or four seconds in its transit, its presence, the duration of its passage, and the degree of thermal obscuration it effects are at once set down.

The cylinder of the radiograph passes over a space of 0·875 of an an inch per hour, a somewhat open range, but, as will be seen on reference to the tracings, the needle often moves for some considerable distance in both directions along the same thin line, thereby showing a practical instantaneity of action under very ordinary thermal changes in the radiance from the sky. The influence of the sun's rays at daybreak is almost always shown, for some minutes at any rate, before the sun himself is seen, and occasionally it would seem even for hours before his time to rise.

It is not, however, now my purpose to dwell upon the interesting changes which take place in the intensity of the thermal radiance from the sky, my present object being to describe an instrument by means of which they may be recorded or observered. Doubtless in several of its details the "Radiograph" may be improved, notably in the condition of its bulbs, and it would unquestionably be better if it computed for itself the areas included by its curves. This, I dare say, I shall presently enable it to do. Meanwhile, as a recorder of the duration and intensity of radiant heat the instrument, so far as I have seen, is the only one whose readings are uninfluenced by the temperature or the pressure of the air.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

January 19, 1880.

C. Bailey, F.L.S., President of the Section, in the Chair.

"*Bog Butter* (*Butyrellite*), *from Co. Galway, Ireland.*"

Mr. John Plant, F.G.S., exhibited a piece of a mineral resin familarly known in the west of Ireland as Bog Butter. The lump weighed exactly 14 ozs. It came from a good depth in a bog in County Galway. A few years ago, when in that part of Ireland, he had been unsuccesful in meeting with a sample of this curious substance, although he was informed that it was not unfrequently met with by the turfcutters during each summer. He heard of its origin and of some of the uses to which it was said to be put by the poor people, if they got any of it, from a farmer at Killkee, but he could hardly credit the statement that in hard times it was melted down and actually used as a dripping to the potatos; he rather concluded that the greasing was limited to the axles of the potato cart. The Irish have a widespread belief that bog butter was hidden by the fairies in the bogs long ages ago; and it is affirmed that the butter is sometimes found in small wooden kegs in bogs along the coast. These kegs they say have been hastily buried by smugglers running a cargo of contraband, though when bog butter was declared an illegal article of trade in Ireland they are unable to say. Unfortunately, Mr. Plant was not shown a keg, or even a staver of a keg, but he was informed that specimens of veritable kegs of bog butter are to be seen in the Museum of the Royal Irish Academy and in the museums at Edinburgh. The fairy origin of the bog butter he thought might be ascribed to the active imagination of the Celtic brain, many of the inexplicable things in nature being readily put down to the good or evil doings of the indigenous fairies of Erin.

By the aid of scientific analysis the substance called bog butter can be shown to be a perfectly natural production arising from the decomposition of the vegetable matters forming the peat or bog, and to belong to the numerous family of mineral resins, or hydrocarbon compounds, of which Dana describes the composition of seventy species.*

Many of these are very well known under the names of marsh gas, petroleum, ozocerite, asphaltum, naphtha, paraffin, bitumen, amber, torbanite, coal, and its varieties.

Some of these singular minerals are obtained only from bog and peat beds.

* Dana, "System of Mineralogy," 5th edition, 1875, pp. 720—760.

Some time ago Mr. Plant showed to the Section a quantity of one of these resinous minerals, which occurred under the bark of pine logs found in a moss at Handforth by Mr. P. G. Cunliffe. It proved to be known in Germany as Fichtelite, but had not before been known to occur in Great Britain. Afterwards it was found in pine logs in the peat on Lindow Common. A waxy, greasy, or butter-like character is distinctive of these bog products. The one now exhibited was described first by Brazier in 1825, and was analysed by Williamson in 1845, its composition being given as

Carbon	73·78
Hydrogen	12·50
Oxygen	13·72

When fresh from the bog it is soft and like butter, but hardens in drying. The mass is dirty and bogstained on the outside, but inside pure white and free from impurities. It melts at 50° C., and becomes a yellow greasy resin, dissolves in alcohol or in ether, and then crystallises in beautiful needles. When heated it gives off a peculiar odour like acroline. By saponification with potash it yields an acid which Brazier proves to have a composition similar to palmitic acid.

There is a mineral waxy resin called Guyaquillite, which is found in extensive deposits in the marshy plains near Guyaquil, in South America, which has a similar composition to bog butter.

ohnson gives it as—

Carbon	76·67
Hydrogen	8·17
Oxygen	15·16

It has been proved that the slow decomposition or change in the vegetable peat or moss will produce elements of which these hydrocarbons are made.

NOTICES OF BOOKS.

Water Analysis for Sanitary Purposes, with Hints for the Interpretation of Results. By E. FRANKLAND, Ph.D., D.C.L., F.R.S. London: Van Voorst.

PROF. FRANKLAND'S experience in connection with the analysis of water for sanitary purposes has been exceptionally great, and the present work, as affording a clear and well-arranged summary of the method which he has been led to prefer, will be highly valued by chemists. We may state in the outset that we have grave doubts whether any of the known procedures for the analysis of water can be received as perfectly satisfactory or as affording more than an approximation to the truth. Were this otherwise a much greater degree of unanimity would prevail amongst chemists, for scarcely anything, in these days, finds its level more rapidly than an analytical method. Yet it is only a short time since one and the same sample of water was submitted to three chemists, all men of standing and of admitted skill, and all specialists in this department of analytical chemistry. Yet what was their verdict? Professor A. declared it totally unfit for use; Professor B. pronounced it fit for drinking, but not fit for washing; and Dr. C. held it fit for washing, but not fit for drinking. Surely, then, water-analysis has not reached that perfection which might reasonably be demanded.

Prof. Frankland has been considered by some speakers and writers too nice, too exacting, in his views of what constitutes a safe drinking-water. Surely, however, in a matter of so much importance it is better to err on the side of safety. It is surely wiser to destroy all the stray dogs of a city rather than let one rabid cur escape, and in like manner it is better to condemn a suspicious water than to recommend it for use. It may be true, as a certain chemist asserts, that 1 part of human excrement mixed with 20,000 parts of water may be drunk with safety, but, loathing apart, we should lack courage to make the experiment. Perhaps some day we shall learn to detect the disease-germs, if such exist, in water.

Prof. Frankland lays little weight on the gases held in solution in a water, and consequently he does not recommend the "hydrosulphite" method for the determination of the oxygen which has recently come into some note in France. Nor does he refer as a preliminary guide to the organisms, animal or vegetable, which are to be met with in streams and wells. For the determination of ammonia, existing in the free state or as ammoniacal salts, he adopts the same process as does Prof. Wanklyn, *i.e.*, distillation along with sodic carbonate, and subsequent Nesslerising. The albuminoid ammonia process, it scarcely need be said, the author does not recognise.

For the determination of nitrogen in nitrates and nitrites Prof. Frankland recommends the "mercury process," but for those who do not practise gas analysis he considers the "zinc-copper couple" of Gladstone and Tribe, and the aluminium process of Chapman, the most convenient. The "indigo method" without certain precautions is apt to give very fallacious results.

As regards the determination of poisonous metals we find no instructions for chromium, which, now potassium dichromate is so extensively employed in dyeing, is liable to find its way into the rivers of the manufacturing districts.

As regards organic impurities, an account is given of the methods of Dittmar and Robinson, of Dupré and Hake, and of what is generally known as the permanganate process. Though admitting that the indications afforded by this last process are true only when the organic matter present is substantially alike in composition, and that there is "no relation between the absolute or relative weight of different organic matters and the oxygen which such matters abstract from permanganate," he yet holds that when the analyst "shrinks from" the combustion-process he will be more likely to rate a water at its proper value by this process than by any other.

The combustion-process is described in full, with the aid of the necessary illustrations. In the evaporation of strongly ammoniacal waters, boracic acid or borax is substituted for sulphurous acid; but as boracic acid does not completely destroy carbonates, a separate carbon determination, with sulphurous acid as the acidifying agent, becomes necessary.

No additional evidence on the accuracy of the combus-bustion-process is adduced, nor do we find any reference to the source of error recently pointed out as common to this and to Prof. Wanklyn's process, *i.e.*, the possible escape of volatile organic matter during evaporation or ebullition.

An Appendix contains a list of the reagents necessary for water-analysis, a selection of useful tables, and certain remarks taken from the Reports of the late Rivers' Pollution Commissioners.

The author evidently prefers spring and deep-well waters for dietetic purposes. But as it cannot be shown that they are more salutary than mountain waters, and are very ill-fitted for boiling vegetables, for washing, and for manufacturing uses, the palm should surely be awarded to the soft mountain and moorland waters, which are preferable for every purpose save drinking and brewing.

We quite agree with Prof. Frankland that the Lea and the Thames should be abandoned as sources of potable waters, and indeed that rivers flowing through populous and cultivated districts should be entirely rejected. With his commendations of the water of the Kent Company we cannot fully agree. To wash the person with it is, to anyone who has lived in the north of England or in Scotland, simply misery, and the waste of soap involved is very serious.

Glasgow Sewage. Reports by Dr. W. Wallace, F.R.S.E F C.S., &c., from May 20 to November 7, 1879.

Dr. Wallace has reports here on experiments made to determine the action of the purified sewage of Glasgow upon the water of the Clyde. For this purpose a portion of sewage was treated with lime alone in the proportion of one ton per million gallons, and another portion with sulphate of alumina and lime, of course in succession. The two effluent waters, after filtration through pounded coke, were mixed with eight times their bulk of clean (?) Clyde water, such being the proportion which the sewage of Glasgow bears to the ordinary flow of the Clyde. The samples were then kept both in closed and open vessels for six weeks. During the whole of this time they remained clear and transparent, and free from odour. On analysis nearly the whole of the ammonia had disappeared, whilst nitrites were present in considerable quantity. Hence it appears that, even without contact with the air, the admixture with eight times its bulk of Clyde water is sufficient to oxidise and render harmless the organic matter in the purified sewage. The crude sewage is not oxidised in the same manner. It is remarkable that the organic ammonia remaining in the sewage after treatment with sulphate of alumina and with lime respectively is alike 0·28 grain per gallon.

Dr. Wallace also reports on the sewage-systems now in operation in a number of English towns. He makes the very judicious remark that wherever macadamised roads exist, in a drainage the quantity of sludge and the proportion of useless material in it are comparatively large. He finds, from observations in Leeds, that lime is incapable of removing the deep brown colour due to the waste waters of the tanneries. This colour we always found was very readily destroyed by sulphate of alumina, especially if containing a little free acid.

Concerning the quality of the sulphate of alumina used at Coventry, the author remarks that a material of the cheapest kind may be successfully employed. With this, we must, in the main, agree. The presence of salts of iron, within any moderate proportion, and of free sulphuric acid are quite unimportant. The question simply is, what does the soluble alumina cost per unit?

In describing his visit to the Aylesbury works, the author remarks that it would be impossible to obtain sufficient refuse carbon for treating the sewage of a large town. This is a difficulty which we admit cannot be overlooked. Dr. Wallace, however, seems to overrate the facilities for the disposal of sewage sludge which are to be found at Aylesbury. There are few districts where there is a smaller proportion of land under tillage.

With the results of irrigation as seen at Croydon Dr. Wallace was not fascinated. He found "the ground quite sodden, the vegetation by no means luxuriant, and the ground in some places swarming with a small species of fly."

The author is not an advocate of the costly system of double sewerage recommended by some authorities. At least he very rightly considers that soapsuds, the water in which vegetables have been boiled, &c., as objectionable and as unfit to be admitted into a river as the outflow from water-closets.

This little pamphlet may be recommended to municipal authorities, as being fairly and impartially written, and free from that spirit of partisanship by which the solution of the sewage question has been so much retarded.

Animals Injurious to the Sugar-canes in Brazil.—E. Guignet.—An account of M. Capanoma's process for destroying the terrible Saüba ants. Some litres of carbon disulphide saturated with sulphur are poured into the galleries of these depredators, and the solution is fired by means of a fuse. The ants are killed by the explosion or by the fumes evolved.—*Moniteur Scientifique.*

CORRESPONDENCE.

VOLUMETRIC ESTIMATION OF MANGANESE.

To the Editor of the Chemical News.

Sir,—May I ask permission to point out that while Mr. Pattinson's three experiments (Chemical News, vol. xli., p. 180) sufficiently show that $CaCl_2$ is not equally effective with Fe_2Cl_6 in preventing MnO_2 carrying MnO down with it when the solution containing the Mn is treated by Mr. Pattinson's method,—or, rather, by Mr. Pattinson's modification of the method which I introduced more than ten years ago,—they prove nothing as to whether or not all the Mn is precipitated as MnO_2 when the solution containing the Mn is treated by that form of the method which I had introduced into nearly all chlorine works years before Mr. Pattinson's experiments with respect to the precipitation of Mn by solution of bleaching-powder were begun. In the three experiments referred to, Mr. Pattinson added, to a solution of $MnCl_2$, calcium carbonate and bleaching-powder solution, "under the conditions," he says, "which I have found to give the best results." We can only suppose, therefore, that the precipitation was made at the temperature recommended in his paper in the *Journal of the Chemical Society* for June, 1879, namely, at about 160° F. By my method, however, no calcium carbonate is used, and the solution of $MnCl_2$ is *boiled* with the bleaching-powder solution, the latter being added gradually to a boiling solution of the former until a faint rose colouration, due to permanganate, appears.

Mr. Pattinson has not published any results stated to have been obtained by precipitating the Mn exactly in this way. He speaks of "two precipitations made when the solutions were boiling," but he gives no particulars with respect to them, except the fact that all the Mn present was not obtained as MnO_2; and for all that appears he may have used too great an excess of bleaching-powder solution, and so have brought into solution as permanganate more of his Mn than the mere trace which alone becomes permanganate when the instructions for the determination of manganese which I have given to nearly all works' chemists having to do with the Weldon process are exactly followed. Moreover, he probably employed a *neutral* manganese solution; and I long ago found that the manganese solution must be acid, or the result would be too low. The reason is that ordinary bleaching-powder solution contains an appreciable quantity of CaO, which precipitates MnO from a solution of $MnCl_2$ not containing any free acid, which MnO at once combines with MnO_2 to form Mn_3O_4, the MnO in which compound cannot be completely peroxidised by boiling with solution of bleaching-powder.

Pressure of other work has as yet prevented any complete examination in my laboratory of the effect of the presence of ferric chloride with a solution of manganese treated by solution of bleaching-powder; but I cannot doubt that one effect of it is to hinder the precipitation of any Mn as MnO. I could not have doubted this, even in the absence of the experimental results of so accurate a worker as I well know Mr. Pattinson to be. All I do doubt in the matter is, whether the result got by Mr. Pattinson's method is more accurate than that got by boiling a slightly acidified dilute solution of $MnCl_2$ with enough bleaching-powder solution to produce a faint permanganate colouration. In the only comparative experiment I have yet been able to have made, my method gave $MnO_2 = 100$, and Mr. Pattinson's method gave $MnO_2 = 100{\cdot}26$.

I hope soon to determine which result is the more accurate. In the meantime the question between Mr. Pattinson's method and my own is merely a question of 0·26 per cent.—I am, &c.,

Walter Weldon.

Rede Hall, Burstow,
April 20, 1880.

CATALYTIC FORCE AND THE NASCENT STATE.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xli., p. 176, I see that Dr. D. Tommasi has referred to my prize essay on Catalytic Force, and has quoted a passage from it. I have already quoted *other passages* from it in recent numbers of your journal, and therefore shall not discuss the matter any further. I thank Professor Tommasi for the complimentary terms in which he has thought proper to speak of this work of my youthful days, and regret that my views do not correspond with his own.

Allow me to inform you that a copy of my memoir exists in the library of the Royal Society, and another in that of the Chemical Society of London, where those who are interested in the question may consult the *original text* of my "Force Catalytique ou Etudes sur les Phenomènes de Contact," besides which many of our English Scientific Societies possess the complete collection of the Transactions of the Société Hollandaise.—I am, &c.,

T. L. Phipson.

Putney, April 24, 1880.

AMMONIA FROM ATMOSPHERIC NITROGEN.

To the Editor of the Chemical News.

Sir,—In this week's issue of the Chemical News (vol. xli., p. 195) there is a note, signed by J. H., respecting Rickman and Thompson's process for the production of ammonia (in the form of chloride) from atmospheric nitrogen and nascent hydrogen, wherein J. H. says that he has obtained a copy of the patent, filed March 15th, and he finds that it is only a "preliminary specification" (provisional ?), and that he in consequence has some difficulty in arriving at facts; but, judging from what he can ascertain, he is of opinion that the *bulk* of the ammonia they obtain comes from the nitrogen in the coal.

Now with regard to the provisional specification filed March 15th. It is clear that somebody must have made an error somewhere, because, if a provisional specification were filed March 15th, it would not yet be published for four months to come. Moreover, a provisional specification is never published apart from the complete specification, unless the patent is carried no further than the provisional stage; but this patent is carried further, and the complete specification can be obtained if in print, and if not can be inspected at the Patent Office.

Secondly, J. H. is of opinion that the *bulk* of the ammonia is produced from the nitrogen of the coal,—that is to say, practically, the whole. If that were so it would be folly to think of making it a direct manufacture. As a by-product, of course, it counts as supplementary profit; as a direct manufacture, nothing, the amount of ammonia from the nitrogen of a ton of coal being so small. As a matter of curiosity they always ascertain the amount of nitrogen in each batch of coal or coal-dust used, but the quantity is so inconsiderable that it has no practical effect. Of the different kinds of coal with which they have experimented they have found Hetton coal to contain the most, being 0·39 p. cent N—but it is a coking coal, therefore not so suitable as a non-coking coal, if even the contained nitrogen had been of any importance; Derby Brights contain 0·36 per cent, and Hard Steam 0·33 per cent N; but coal-dust, which they prefer to use and are now using, contains only 0·36 per cent N. This amount of nitrogen will produce but a very small amount of ammonia per ton of coal,—only about 7 lbs., equal to about 21 lbs. of chloride; but this is double the amount produced from the nitrogen of the coal in actual work in gas-factories. A ton of coal gives 10,000 cubic feet of gas, and each cubic foot of gas contains about 2·4 of ammonia, which is for the ton of coal 54½ ozs., or about 3½ lbs. Now it is not uncommon to produce 50 ozs. NH_4Cl from less than 20 lbs. of coal-dust, which is equal to about 350 lbs. to the ton; and this is more than 16 times that which the nitrogen in the coal would produce if it were all utilised, and 33 times that actually produced in gas-factories. So that it would appear that the *bulk* of the ammonia produced by Rickman and Thompson's process is really from the nitrogen of the atmosphere, and not from the nitrogen in the coal.

I begin to doubt whether any of the ammonia produced in gas-factories is from combined nitrogen in the coal, about which I may have something more to say.—I am, &c.,

J. B. T.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Justus Liebig's Annalen der Chemie,
Band 200, Heft 1 and 2.

Researches from the Chemical Institute of the University of Strasburg.—These consist of a paper by R. Fittig and H. Liepmann on fluoranthren, a new hydrocarbon in coal-tar; researches also by R. Fittig on the non-saturated acids, such as the mono-basic acids, with six atoms of carbon, the ethyl-crotonic, the hydrosorbic, and the pyroterebic, also on methyl-acrylic acid; on the decomposition of the substitution products of the lower fatty acids by water. The experiments in these various instances have been performed by students under Prof. Fittig's direction. These Strasburg researches further include a memoir on phenyl-lactimide, by Ed. Posen; a notice by H. Schmidt on the preparation of the neutral glycerin-ether acetate, and a paper by Fr. Jourdan on the synthesis of normal nonylic acid, and of an acid isomeric with the palmitic.

Various Nitriles from Hydrocyanic Acid and Ethyl-aldehyd-ammonia, according to the Experiments of Dr. S. C. Passavant.—E. Erlenmeyer.—An extensive memoir, not adapted for useful abstraction.

The Chemical Constitution of Organic Bodies with Reference to their Density and their Power of Transmitting Light.—Dr. J. W. Brühl.—The author expresses the law which he seeks to establish thus:—(1.) The atomic refraction of the univalent elements is independent of their position in a compound body. It is constant, no matter with what other atoms the former class are combined. (2.) The atomic refraction of carbon and of the polyvalent elements in general is variable, and depends on their mode of combination. If carbon binds a separate atom with each valence, its atomic refraction for that part of the spectrum independent of the wave-length = 4·86; but in case of double catenation with other atoms of carbon it = 5·86.

$$rAC' = 4{\cdot}86.$$
$$rAC'' = 5{\cdot}86.$$

(3.) The molecular refraction of organic bodies is determined by the kind and number of their atoms, and is affected also by their number. It can be calculated only when the chemical constitution is known, using the refraction peculiar to each atom according to its manner of combination. The molecular refraction is then the sum of the specific refractive power of the constituent atoms.

Studies on Quinic Acid, Quinon, and on Connected Bodies.—O. Hesse.—The author remarks that quinic acid forms in all cases anhydrous crystals. He examines its behaviour with acetic anhydride, bromine, concentrated hydrochloric acid, and soda. Quinon is readily soluble in boiling petroleum ether, and better still in boiling ligroin, from both of which it is chiefly deposited on cooling in fine yellow crystals. He considers this body as the aldehyd of quinic acid. The memoir contains also ob-

servations on hydroquinon, diacetyl-hydroquinon, dipropionyl-hydroquinon, quinhydron, phenoquinon, and methyl-quinhydron.

Alleged Non-existence of Pentathionic Acid.—F. Kessler.—A reply to W. Spring (*Annalen*, 199, 97). The author, in this preliminary communication, asserts that the acid which he obtained by the decomposition of sulphurous acid and sulphuretted hydrogen had the composition S_5O_5, and was consequently a true pentathionic acid.

Postscript on the Nature of Pyroterebic Acid.—Jul. Bredt and R. Fittig.—The body hitherto regarded as pyroterebic acid, *i.e.*, the product of the dry distillation of terebic acid, is, in spite of its constant boiling-point, a mixture, and consists chiefly, not of an acid, but of lacton.

Moniteur Scientifique, Quesneville.
February, 1880.

Industrial Society of Mulhouse : Sessions of the Chemical Committee.—At the meeting, November 12, M. Prud'homme exhibited specimens of woollen cloth dyed with the "alizarin-carmine" of Przibram and Co. This colour is the potassium or sodium salt of sulphoalizaric acid. It was first accidentally produced by the oxidation of anthraquino-sulphurous acid. Alizarin-carmine is a deep violet powder, and dissolves readily in water with a magenta shade.

Review of Toxicology.—A. Vernon.—Extracts from the memoirs of M. F. Selmi, as originally published in the *Transactions* of the Lyncean Academy.

Narcotin, Cotarnin, and Hydrocotarnin.—G. H. Beckett and C. R. Alder Wright.—A lengthy translation from the English.

Volumetric Determination of Active Oxygen in Barium Binoxide and in Oxygenated Water.—Armand Bertrand.—Inserted at length.

Dimethyl-naphthyl-amin and Naphthoquinon.—P. Monnet, F. Reverdin, and E. Noelting.—The authors have not succeeded in obtaining colouring matters by the oxidation of dimethyl-naphthyl-amine. Naphthoquinon yields with aniline and dimethyl-aniline in presence of sulphuric acid fine red and violet colourations, and with phenol and resorcin compounds, which form with alkalies red and fluorescent solutions.

Action of Heat upon Metals in a Vacuum.—T. A. Edison.—A paper read at the Saratoga Meeting of the American Association for the Advancement of Science.

Falsifications of Alimentary Substances.—A summary of the English and German laws on the adulteration of food.

NOTES AND QUERIES.

Electro-deposition of Lead.—Can you tell me where I can find any information about the electro-deposition of lead? I can succeed in getting a thin coating upon copper, but cannot increase the thickness. It is very much wanted for machinery where sulphuric acid is used.—M.B.

Keeping Salts of Ammonia.—(Reply to H. J. Bland.)—I beg to state that muriate of ammonia kept in dry sheds does diminish in weight, and that to a considerable extent: the loss is increased when the muriate is stocked through a hot summer. Sulphate of ammonia oses weight also. This statement is the result of absolute experience, and is made with reference to a large quantity.—H. RAYNER.

Distillation of Hydrocarbons.—Will some chemist kindly account for the following?—In the distillation of coal in a small iron retort, I have found the results of illuminating hydrocarbons vary to the extent of 20 per cent with other iron retorts, the test being made with the same coal and under precisely similar concitions. I have gathered from this that the iron of the retorts must have varied in composition, and that a chemical combination must have occurred with one kind of iron more than another, the temperature of the iron being in all cases about 2000° F. If someone will kindly give me the benefit of their experience or judgment I shall esteem it a favour. —E. W.

ERRATUM.—P 191, col. 1, line 6, *for* "E. Rawson" *read* "C. Rawson."

MEETINGS FOR THE WEEK.

MONDAY, May 3rd.—Medical, 8.30.
—— Society of Arts, 8. Robert W. Edis, F.S.A., "The Decoration and Furniture of Town Houses."
—— Royal Institution, 5. General Monthly Meeting.
TUESDAY, 4th.—Civil Engineers, 8.
—— Zoological, 8.30.
—— Pathological, 8.30.
—— Royal Institution, 3. Mr. R. H. Scott, "Wind and Weather."
WEDNESDAY, 5th.—Society of Arts, 8. John C. Morton, "Agricultural Experiences: the Lesson of Forty Years."
THURSDAY, 6th.—Royal Institution, 3. Prof. Tyndall, "Light as a Mode of Motion: Theories of Light and Colour."
—— Chemical, 8. Dr. Hodgkinson, "On the Action of Sodium on Etherial Salts of Phenyl Acetic Acid." C. E. Groves, "Estimation of Nitrogen in Carbon Compounds." Mr. M. P. Muir, "On Sage Oil." Dr. W. Ramsey, "On the Electrical Conductivity of Solutions."
FRIDAY, 7th.—Royal Institution, 8. Prof. Flower, "Fashion in Deformity."
—— Geologists' Association, 8.
—— Society of Arts, 8. Mr. W. Robertson, M.R.C.A., "The Present Condititon and Prospects of Agriculture in South India."
SATURDAY, 8th.—Royal Institution. Prof. Morley, "The Dramatists before Shakespeare," 3.
—— Physical, 3.

THE JOURNAL OF SCIENCE
for May (Price 1s. 6d.), includes—
Offensive and Defensive Torpedo War. By Capt .S. P. Oliver.
The Soul: What is it?
Internal Enemies.
The Antiquity of Mankind.
On Water and Air. By Prof. Tyndall, D.C.L., LL.D., F.R.S. (Lecture IV.) Illustrated.
Analyses of Books. Correspondence. Notes.
London: 3, Horse-Shoe Court, Ludgate Hill.

NEW AND ENLARGED EDITION.
Now ready, in crown 8vo., with Frontispiece, price 12s.
HEAT A MODE OF MOTION. By JOHN TYNDALL, F.R.S, D.C.L., LL.D., Professor of Natural Philosophy in the Royal Institution of Great Britain. Sixth Edition (Thirteenth Thousand), thoroughly revised and augmented.
London: LONGMANS and Co.

SULPHATE OF SODA AND HYDROCHLORIC ACID.
This day is published in 8vo., 708 pp., with 267 Woodcut Illustrations, drawn to scale, Price 36s., Volume II. of
A THEORETICAL AND PRACTICAL TREATISE
ON THE
MANUFACTURE OF SULPHURIC ACID AND ALKALI,
WITH THE COLLATERAL BRANCHES,
By GEORGE LUNGE, Ph.D., F.C S.,
Professor of Technical Chemistry at the Federal Polytechnic School, Zürich; formerly Manager of the Tyne Alkali Works.
VOL. I. SULPHURIC ACID, Uniform, 658 pp., 309 Illustrations, £1 16s
VOL. III. (In the press) will complete the work.
JOHN VAN VOORST, 1, Paternoster Row.

CITY AND GUILDS OF LONDON INSTITUTE
FOR THE
ADVANCEMENT OF TECHNICAL EDUCATION,
CHEMICAL TECHNOLOGY.
PROFESSOR ARMSTRONG, Ph.D., F.R.S., will give a Course of Twelve Lectures, commencing May 10th, 1880, on Fuel and Electro-Deposition of Metals, and a Course of Tutorial and Laboratory Instruction in Photographic Chemistry, at the temporary Laboratories of the Institute, Cowper Street Schools, Finsbury.
Detailed Prospectuses of Instruction to be had on application to
PHILIP MAGNUS, B.Sc., B.A.,
Director and Secretary.
Gresham College,
Basinghall Street, E.C.

ON SALE.—A 300-gallon Wrought-Iron Jacketed Still and Copper Condenser, capable of condensing and cooling 60 gallons strong spirit per hour, fitted with brass safe and hydrometer jars complete. One 750-gallon store cask, lead-lined, with man-hole, perfectly air-tight. To be had cheap.—Apply, C. Bogaerts and Co., Bradford, Yorkshire.

SPECIALITIES.

MANGANESE Finest Crystallised, Lump, Ground, and Granulated of every quality, and PREPARED for *Chlorine, Glass, Steel, Ferro-Manganese, Pottery, Battery,* and EVERY PURPOSE.

BAUXITE (Hydrate of Alumina) Of high percentage of Alumina and almost free from Iron. The CHEAPEST, BEST, and MOST PROFITABLE article from which to produce ALUM, ALUM CAKE, and SULPHATE OF ALUMINA, &c. [BRAND, "IRISH HILL BAUXITE."]

FLUOR-SPAR Of the Very Finest Quality for Acid, Soda, Glass Flux, and all purposes.

BARYTES (Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

CRYOLITE, Magnesite, Felspar, Arsenic, Phosphates French Chalk, Strontia, Wolfram, Chrome, Terra Alba, Rotten Stone, China Clay, Umbers, Ochres, Antimony, Calamine, Emery Stone, all Oxides, and all

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,
MINE PROPRIETOR,
Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.
OFFICES—26 CHAPEL STREET, LIVERPOOL.

WILLIAM AND WILLIAM T. FIELD,
MANUFACTURERS of the Celebrated STAFFORDSHIRE BLUE BRICKS, specially adapted for Chemical Plant, *i.e.*, Acid Towers, &c. Also all other kinds of Best Staffordshire Blue Bricks, Pavings, Plynths, Splays, Copings, &c. &c. Prices and samples on Application.

TESTIMONIAL.

"We have used the Blue Staffordshire Brick for Sulphuric Acid Towers, &c., manufactured by Messrs. Field, for the last fifteen years, during which time they have given great satisfaction. We recommend them to the Chemical Trade, believing there is nothing better in the market."—(Signed) WILLIAM HUNT and SONS, Lea Brook Alkali Works, near Wednesbury, Staffordshire, February, 1878.

TOLL END BRICK-WORKS,
TIPTON, STAFFORDSHIRE.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA.

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

ORGANIC MATERIA MEDICA.
By DR. MUTER.

Analytical Chemists will find this a concise and yet complete book of reference for the isolation and examination of the active principles of drugs. Special appendix on the microscopic characters of the starches in food and drugs. Copious index and qualitative courses or resins, &c.

Published by W. BAXTER at the Office of the South London School of Pharmacy, Kennington Cross, S.E., and sold by Messrs. Simpkin and Marshall and Messrs. Baillière, Tindal, and Cox.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44 Berners-street W.

Wanted, a Buyer of 8 to 10 Tons weekly of Crystallised Sulphate of Soda (Glauber salts), in cask or bulk.—Apply to "Glauber Salts," 168, St, Helen's Avenue, Swansea.

GREENBANK ALKALI WORKS COMPANY
(LIMITED),
ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{2}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{100000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

THOMAS ADKINS & CO.,
SMETHWICK,
NEAR BIRMINGHAM

MANUFACTURERS OF SPECIALLY PREPARED RED LEAD FOR FLINT-GLASS MAKING.

CHEMICAL & PHYSICAL APPARATUS,
BOTTLES, PURE CHEMICALS,
REAGENTS, STANDARD SOLUTIONS,
And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

MOTTERSHEAD & CO.,
7, Exchange Street and 10, Half Moon Street,
MANCHESTER.

DAHL & CO.,
BARMEN (RHENISH PRUSSIA),
MANUFACTURERS OF
ANILINE AND NAPHTHALINE COLOURS.
SPECIALITY—Ponceau Naphthol-Reds as a Substitute for Cochineal.
Sole Agency and Depôt in England,
THEODOR BANG,
BENSON'S BUILDINGS, BASINGHALL ST., LEEDS.

THE CHEMICAL NEWS.

VOL. XLI. No. 1067.

MEASUREMENT OF THE ACTINISM OF THE SUN'S RAYS AND OF DAYLIGHT.*

By Dr. R. ANGUS SMITH, F.R.S.

WHEN examining the air of towns and the effect of smoke and fogs, I have often wished for a very simple chemical method of measuring the total light absorbed by these gases, vapours, and floating solids. I do not undervalue the work of others, but I think I have obtained a process promising good results with great simplicity, although I dare say it introduces its own class of difficulties.

The fundamental fact is that when iodide of potassium in solution is treated with nitric acid, so small in quantity as to cause no change of colour in dull diffused light, a change takes place when the same mixture is brought into clear light; iodine is set free and the solution becomes yellow.

2. The amount of iodine freed can be titrated with great exactness by the use of hyposulphite, as is well known.

In these two facts lies the whole process, the first is the new part, the second makes the first quantitative, and its use is of course part of the novelty.

3. It is known that strong acid liberates iodine. Weak acid does so after a long time, but the process is hastened by light.

4. Heat even to the boiling point does not act so well as light (experiments being made in sealed tubes to prevent loss of iodine).

5. Heat assists the action of light.

6. A solution may be exposed day after day so as to give the accumulated effect of sunlight, in a measurable condition at the end of the time.

7. The solution of iodide of potassium as hitherto obtained is subject to change. An old solution, that is, one nearly a month old, was found more sensitive than a new one in all cases tried.

8. The result of No. 7 is, that a certain allowance may require to be made for this, in those cases where the periods of observation with one solution are long.

9. The amount of allowance to be made for temperature is not made out. It is not certain that any is required in the cases when weak acid is used. The weather has not allowed any combined action of great light and heat, but with heat and light in the rays from an electric light with a parabolic reflector, the action was very rapid.

10. Specimens of experiments (prospective at first). It was found convenient to use a solution of 2 grms. of iodide of potassium, afterwards changed to 1 grm., in 100 of water, and to use half of this for an experiment, *i.e.*, 50 c.c. of the solution which may be called A.

A nitric acid solution having an acidity equal to 1 per cent of sulphuric anhydride was made; this may be called B. Only very small portions of B were added to A.

The experiments were made in wide test-tubes, and here are early trials:—

13th February.

50 c.c. of A with 0·2 c.c. of B; no action in three hours.
50 c.c. „ 0·4 „ action; } not looked at before the
50 c.c. „ 0·8 „ decided action; } end of 3 h.

No colour in a shaded part of the room in 420 hours in liquids of the same strength.

49·0 c.c. of A with 1·0 c.c of B; colour after 40 mins.
48·8 „ 1·2 „ „ 35 „
48·5 „ 1·5 „ „ 30 „
(Sunshine and cloud alternately.)
48·5 c.c. of A with 1·5 c.c. of B; in the diffused light of the laboratory; no colour after 4 hours.

Here we have action in sunlight in proportion to the acid. The acid gives delicacy. The light commences the chemical action.

Examples in which the decomposition was measured by a solution of hyposulphite of sodium, which may be called solution C = 0·1 grm. per litre of iodine (or as convenient). I shall extract experiments made with B solution 0·8 c.c., because it is an intermediate one (0·2, 0·4, 0·8, 1·6, and 3·2 have hitherto been the favourites).

1880.		B sol.	Hours.	Measure by C solution (hyposulphite).
Mar. 3.	Sunshine and cloud alternately.	0·8	After 2½	8·1, 1st colour in 20'
„ 4.	Sunshine	0·8	„ ..	1st colour in 30'
„ 5.	Dull all day	0·8	„ 4	0·9
„ 8.	Sunshine	0·8	„ 2½	7·5, colour in 20'
„ 9.	A little sunshine	0·8	„ 2½	4·8
„ 10.	Foggy, with a gleam of sunshine	0·8	„ 6	1·5
„ 11.	Bright	0·8	„ 2½	7·2
„ 12.	Dull and wet	0·8	„ 3	0·6
„ 13.	Dark and dull	0·8	„ 2½	Faint trace
„ 15.	Changeable	0·8	„ 2½	1·8
„ 16.	Changeable	0·8	„ 2½	1·6
„ 18.	Sun through haze	0·8	„ 2½	5·8
„ 19.	Bright	0·8	„ 2½	11·5
„ 20.	Fog till 11.30	0·8	„ 2½	3·2
April 1.	Sun and showers	0·8	„ 2½	1·6

Example of one day's observations showing the measured amounts after 2½ and 7 hours. C solution gives the proportion of light effect.

8th March. Sunny.

B sol.	C sol. required after 2½ hours.	C sol. required after 7 hours.
0·2 c.c.	1·25 c.c.	5·2 c.c.
0·4 „	4·1 „	11·1 „
0·8 „	5·8 „	17·5 „
1·6 „	9·8 „	27·0 „
3·2 „	12·8 „	33·3 „
6 4 „	17·8 „	34·8 „

The rate of increase of decomposition requires to be learned, also the most convenient solutions of B for every light and perhaps temperature.

Effect of temperature. Tubes exposed to daylight during a dull day.

B sol.	C sol. required.	
0·2	0·15	
0·4	0·90	.. Temperature = 12·8° C.
0·8	1·00	
1·0	3·20	
1 6	6·00	

These were in duplicate to begin with, but finding after an hour and a half that almost no action had taken place one-half were put into the dark. At the end of the day the result was:—

B solution.	C solution required.	
0·2	0·0	
0·4	0·0	
0·8	0·1	.. Temperature = 11·1° C.
1·0	0·1	
1·6	0·2	

It is seen that with an almost equal temperature the action is very decided in light on a dull day, but scarcely measurable in darkness.

* A Paper read before the Royal Society, April 29, 1880.

To further the effect of heat the following were tried:—

Temp. 12·8° C. in light.		Temp. 25° C. in darkness.	
B sol.	C sol. required.	B sol.	C sol. required.
0·4	0·4	0·4	0
0·8	1·3	0·8	0
1·0	1·9	1·0	0
1·6	5·2	1·6	?

It was suspected that not only did the iodide solution change by keeping, but the nitric acid also, weak as it was, Indeed I had once a mode projected of measuring light by the decomposition of nitric acids or nitrates, but I did not expect this to take place in such weak solutions.

To avoid this change, sulphuric acid was tried with the following result. This trial serves also as a test for the effect of light separate from heat.

2½ hours exposure to not very bright clouds:—

Temp. 12° C. in light.		Temp. 20° in dark.	
Sulphuric acid used, same acidity.	C sol. required.	Sulphuric acid.	C sol. required.
0·4	0·5	0·4	0
0·8	3·9	0·8	0
1·6	4·9	1·6	0
3·2	6·1	3·2	0

11. There seems, therefore, no reason to doubt that this is a true photometric process, with special capacities to be developed in time. I may add that I did obtain better results at the window of my house than at the laboratory at the same time, the latter being nearer the centre of the town; thus the process has done the duty it was intended for, although only once tried for this special purpose. I am looking to it as an agent specially for the examination of climate, but of course it may have many uses. This process does not aim at delicacy, but at accumulation of effect. I have not spoken of a standard; the results are only comparative, but the process may be made to supply its own standard.

12. Since writing the above, it appears that by using sulphuric acid some of the fears at first entertained may be avoided, as is shown by the following extract:—

B sol.	C sol. required after 2½ hours' exposure of A to light.	C sol. required after 50 hours' exposure of A to darkness.
0·2	7·6	0·3
0·5	15·1	0·6
1·0	23·4	0·6
2·0	30·4	0·7
4·0	43·6	0·7
6·0	53·8	1·3

The temperature of the solutions exposed to light = 13° C., kept in darkness = 22° C.

The strength of solutions and the kind of acid to be used may vary. Similar results may be got by using bromide of potassium, but it is less delicate.

REVISION OF THE ATOMIC WEIGHT AND VALENCE OF ALUMINIUM.*

By J. W. MALLET, F.R.S.

After remarking that there is probably no one of the so-called chemical elements equally abundant in nature with aluminium, and occurring in as numerous compounds, with regard to the atomic weight of which our knowledge has long rested upon so slender a foundation of accurate experiment, the author gives a brief statement of prior determinations, noticing in succession the researches of Berzelius, Sir Humphry Davy, Thomson, Mather, himself, Dumas, Charles Tissier, and Terreil, and quotes the numbers given in several of the more recent chemical handbooks, reports, &c.

He then proceeds to describe a re-determination of this atomic weight, which occupied a large part of his leisure time during the last three years. In this investigation he spared no pains to attain as precise a result as possible, and aimed especially at the discovery, and as far as possible removal, of sources of error connected with the methods employed. The following general principles were kept in view:—

1. That each process should be as simple as possible, and should involve as little as possible of known liability to error.
2. That different and independent processes should be resorted to as the means of checking each other's results, even though it may fairly be assumed that one is more advantageous than another.
3. That each process should be carried out with quantities of material differing considerably from each other in successive experiments.
4. That only such other atomic weights should be involved as may be counted among those already known with the nearest approach to accuracy.

The most scrupulous care was taken in the purification and examination of all the reagents used, and as far as possible, vessels of platinum or of hard porcelain were substituted for those of glass.

In the author's first series of experiments the alumina was determined which resulted from the ignition of a known weight of ammonium alum.

In the second series a solution was made of a known weight of bromide of aluminium, and was very exactly precipitated by a solution of nitrate of silver, and the weight of bromide of aluminium compared with that of the silver required for forming the solution of nitrate.

In the third series bromide of aluminium was used for the preparation of pure aluminium, by reduction by sodium; a carefully weighed portion of the pure aluminium was dissolved in a solution of caustic soda, and the hydrogen given off was estimated by volume or else burnt, and the weight of resulting water determined.

In the following epitome of the results A, B, C denote groups of experiments under each series, the experiments of each group differing only in the quantity of material operated on, while the different groups differ in the particular preparation used, or in some feature of the method. Thus in Series I. A was made with alum dried by exposure to air for two hours; B with alum dried by exposure for twenty-four hours. In Series II. A, B, C were made with successive portions of a distillate of bromide of aluminium. In Series III. A was made by estimating the hydrogen by volume, B by estimating by weight the water resulting from its combustion. Only the number of experiments in each group, the mean result from the group, and the probable error of the mean, are here given.

Series I.

	A.	B.
No.	5	5
Mean	27·040	27·096
P. e.	±0·0073	±0·0054

Series II.

	A.	B.	C.
No.	3	5	3
Mean	27·034	27·023	27·018
P. e.	±0·0049	±0·0052	±0·0069

Series III.

	A.	B.
No.	6	3
Mean	27·005	26·990
P. e.	±0·0033	±0·0046

In view of the gradual loss of water which crystallised ammonium alum has been shown to undergo on exposure to the air, the author considers that of these various sets of experiments Series I., B, is entitled to least confidence

* Abstract of a Paper read before the Royal Society, April 22, 1880.

He is inclined to attach most weight to Series III., A, since the method used was very simple in principle, the determination of one of the two quantities concerned was rendered very exact by the great volume occupied by the hydrogen, the comparison was made directly with the standard element in our system of atomic weights, and not through the intervention of any other substance whose atomic weight must be assumed, and the agreement of the results among themselves is particularly good.

The general mean from all the thirty experiments, if all be included is Al = 27·032, with a probable error for this mean of ±0·0045. If Series I., B, be excluded, the mean of all the remaining twenty-five experiments is Al = 27·019, with a probable error of ±0·0030.

The general result adds, the author hopes, alumininm to the unfortunately still limited list of those elementary substances whose atomic weights have been determined within the limits of precision attainable with our present means of experiment.

This result also adds one to the cases already on record of the numbers representing carefully determined atomic weights approaching closely to integers, and leads the author to say a word on the re-consideration of "Prout's Law." Taking the following eighteen elements as the only ones of which the atomic weights may be fairly considered as determined, with reference to hydrogen, with the greatest attainable precision, or a near approach thereto, namely oxygen, nitrogen, chlorine, bromine, iodine, sulphur, potassium, sodium, lithium, silver, thallium, aluminium, carbon, phosphorus, barium, calcium, magnesium, and lead, and making a reasonable allowance for the errors of the determinations, he calculates the probability that nine of those numbers should lie, as they are found to do, within 0·1 of integers, supposing the value of the true numbers to be determined by chance, and finds it only as 1 to 235·2. The exact figure for the chance will of course depend upon the limit of error taken; but the above example seems sufficient to show that not only is Prout's law not as yet absolutely overturned, but that a heavy and apparently increasing weight of probability in its favour, or in favour of some modification of it, exists, and demands consideration.

THE APPLICATION OF THE ELECTRIC CURRENT IN ANALYTICAL CHEMISTRY.

By C. LUCKOW.

The electric current is capable of varied application both in quantitative and qualitative analysis. It can effect the solution of metals and alloys at the + pole, and the precipitation of certain metals from acid solutions, and of others from alkaline solutions, or from neutral solutions mixed with acetate of soda. This may take place either at the − pole in the metallic state or at the + pole as peroxide. It also serves for separating metals precipitable out of an alkaline solution from such as cannot be thrown down from such solutions. Thus, copper can be precipitated as a metal and lead as peroxide, being simultaneously separated both from each other and from all the metals of the first four groups, except manganese. The author recommends Meidinger's battery, as giving a constant current for two or three months, and as constantly available, and points out many advantages of the electric separation of metals as compared with ordinary analytical processes. A Meidinger battery of four elements costs about £1, and consumes yearly 25 lbs. sulphate of copper. In acid solutions the electric current has a reducing action, but in alkaline solutions it is an oxidiser. If a current is passed through solutions of the compounds of chlorine, bromine, iodine, cyanogen, ferro- and ferricyanogen with hydrogen, the above-named electro-negative constituents are separated out at the + pole and the hydrogen at the − pole.

Cyanogen undergoes a further decomposition, the final products being carbonic acid and nitrogen. The solutions of ferro- and ferri-cyanogen deposit Prussian blue at the + pole.

In dilute solutions of metallic chlorides there is formed merely hypochlorous acid, accompanied in stronger solutions by chlorine.

In the solutions of the chlorides of the alkaline and earthy alkaline metals a chlorate is formed as soon as the solutions have become alkaline, in consequence of the escape of the hypochlorous acid and of the chlorine. If dilute solutions of chlorides contain little free hydrochloric acid hypochlorous acid alone is formed, and the liquid in course of time becomes alkaline.

From the solutions of the iodides and bromides iodine and bromine are deposited at the + pole, and in case of the metals of the two first groups, especially in concentrated solutions, there are formed iodates and bromates.

Potassic cyanide is decomposed by the current into potassic and ammonic carbonates.

If the solutions of the chlorides, iodides, and bromides contain free alkali, the chlorates, iodates, and bromates alone are formed. From the insoluble compounds of chlorine, iodine, bromine, cyanogen, ferro- and ferricyanogen with the metals in presence of dilute sulphuric or nitric acid, the metal is eliminated at the − and the halogen at the + pole. Hence, for this purpose the − pole is a platinum wire, and the + pole a platinum capsule, in which the metallic compound before the addition of the diluted acid is moistened with a little water, which is evaporated to prevent the adhesion of the metallic compound to the bottom of the capsule.

Concentrated nitric acid is decomposed with the formation of nitrous acid at the − pole. In acid of 1·2 sp. gr. this decomposition does not ensue, at least with a weak current.

Dilute nitric acid between two platinum poles passes into ammonia neither when alone nor in the presence of sulphuric acid. But if dilute nitric acid is mixed with a solution of copper sulphate, and submitted to electrolysis, metallic copper is deposited and ammonic sulphate is formed, all the nitric acid present being thus transformed if there is sufficient copper salt. Ammonia is also formed in the electrolysis of nitrates, except a free alkali is present.

Concentrated sulphuric acid is decomposed with separation of sulphur, but the dilute acid is not, nor is the acid decomposed during the electrolysis of the aqueous solutions of its salts.

Sulphurous acid in aqueous solution is resolved into sulphur and sulphuretted hydrogen; in its salts it is gradually converted into sulphuric acid. The hyposulphites gradually pass into the corresponding sulphates, with separation of sulphur.

The alkaline sulphides are decomposed with or without liberation of sulphur according to the proportion which they contain, and a sulphate is simultaneously formed.

In the solutions of the alkaline sulphites and hyposulphites there is a transitory formation of polythionates along with the production of sulphides.

Phosphoric acid is not decomposed by the current, whether in dilute solution or in the dilute solutions of its salts.

Carbonic acid is very incompletely liberated at the + pole from the solutions of the bicarbonates.

Silicic acid is separated from concentrated solutions as a white mass, and boric acid in dendritic crystals, both at the + pole.

In order to separate the above-mentioned acids from their insoluble compounds with the metals of groups 4, 5, and 6, the insoluble salt is dissolved in sulphuric or nitric acid, in an alkali, or in some suitable salt, or we proceed as laid down for the insoluble chlorides.

We now turn to the behaviour of the electro-positive constituents under the action of the current.

The metals of group 6 are all separated from their solutions in the reguline state.

(1.) From the solutions of the chlorides, also, in presence of free hydrochloric acid, which, if abundant, is neutralised with ammonia, there are separated :—

(*a.*) Antimony from the trichloride or the chlorine compound corresponding to antimony oxide as a dark brown or light grey metallic deposit according to the concentration of the solution. The precipitate is hardly soluble in hydrochloric acid, readily in nitric acid, especially if previously moistened with hydrochloric acid. Antimony is easily and completely thrown down in a reguline state from the solution of emetic tartar.

(*b.*) Arsenic from the trichloride, as dark brown or black graphitic deposit, according to concentration, insoluble in hot hydrochloric acid, readily soluble in concentrated nitric acid and in a solution of sodic hypochlorite.

(*c.*) Tin from the stannous and stannic chlorides as a white deposit with a dull metallic lustre, easily soluble in dilute acids, especially in contact with platinum. In the electrolysis of arsenic and antimony chlorides some arsenic and antimony hydride escapes at the − pole. If all these three metals are present simultaneously, arsenic is deposited first, then antimony, and lastly tin.

(*d.*) Platinum from the dilute solutions of the chloride, to which some solution of sodium chloride may be advantageously added. The deposit is at first reguline; afterwards, when the solution has become very dilute, it takes the form of platinum-black. The deposit from the insoluble double chlorides takes the latter form.

(*e.*) *Gold*, like platinum, is easily deposited from its soluble and insoluble compounds. From solutions in potassic cyanide it is deposited in a reguline form. Platinum vessels in which the precipitation of gold or platinum is conducted should be previously coated internally with a thin stratum of copper or silver.

(2.) From the solutions of the sulphides in alkaline sulphides :—

If care be taken that an excess of alkaline sulphide remains in solution the precipitation of arsenic and tin in the metallic form is complete ; that of arsenic incomplete.

(3.) From alkaline solutions :—

Stannic and antimonic acids dissolve readily in concentrated soda or potassa-lye from which metallic deposits are obtained. The precipitation is very imperfect, and is only rendered complete by the introduction of sulphuretted hydrogen into the alkaline solution, or its acidulation with hydrochloric acid.

Of the metals of group 5 the current throws down :—

(*a.*) Copper completely from solutions containing free sulphuric, nitric, or acetic acid, provided the weight of such free acid, calculated as anhydride, does not exceed 8 per cent of the weight of the solution. If the solutions contain some free hydrochloric acid all the copper is thrown down if sal-ammoniac, common salt, or sodic acetate be added. If ammonia, ammonic carbonate, or potassic cyanide is added to the solutions of neutral copper salts, all the copper is thrown down as a metal.

(*b.*) Silver, from solutions containing not above 8 to 10 per cent of free nitric acid, is deposited in a very bulky metallic state. Some peroxide is also deposited at the + pole, the formation of which is prevented by the addition of a little glycerin, milk-sugar, or tartaric acid. From the solutions of silver-salts in ammonia or ammonic carbonate, the metal is also thrown down in a very bulky form, peroxide being separated out at the + pole, but it is soon reduced to metallic silver. If potassic cyanide is added to neutral or ammoniacal solutions of silver, or if silver-salts, insoluble in water, are dissolved in potassic cyanide, the silver is deposited from such solutions in the reguline form with a dull metallic lustre.

(*c.*) Mercury is completely deposited in the form of drops from mercurous and mercuric solutions. The metal is also readily separated from its insoluble compounds. If other metals are also present amalgams are formed.

(*d.*) Lead, from neutral solutions, is thrown down partly at the − pole as metal, and partly as peroxide at the + pole. A complete metallic precipitation is effected only in presence of easily oxidisable bodies, which hinder the formation of peroxide. From the alkaline solutions of lead, the current precipitates the metal alone in a bulky condition, a slight deposit of peroxide at the + pole disappearing in the sequel. The complete separation of lead as peroxide is effected in a pure solution of lead only in the presence of more than 10 per cent of pure nitric acid. If the solution contains copper also, then even in presence of small proportions of nitric acid all the lead is deposited at the + pole, even though small quantities only of copper were present in solution. Other metals, such as silver and mercury, behave in a similar manner, but include part of the lead in their metallic precipitates.

(*e.*) Bismuth is thrown down in the reguline form from solutions containing some free nitric acid, a little peroxide being deposited at the positive pole. The metal is easily separated as a black mass from the insoluble compounds of bismuth.

(*f.*) Cadmium is completely deposited from the dilute neutral solutions of its sulphate, nitrate, and acetate in the metallic state with a zinc-grey colour. The quantity of the acid liberated in the solution of the sulphate may rise to 1½ to 2 per cent before the precipitatipn of the cadmium is hindered. It is also completely deposited from solutions which have been mixed with an excess of ammonia, or ammonic acetate.

If all the above-named metals of group 5 are present together in a solution containing free nitric acid, mercury and silver are thrown down first, and copper and bismuth not until the greater proportion of the two former metals has been precipitated.

Of the metals of group 4, zinc, nickel, and cobalt are imperfectly precipitated from the solutions of their neutral sulphates, but manganese and uranium are not thrown down at all in a metallic form. If, however, such solutions are mixed with a solution of an alkaline acetate, tartrate, or citrate, zinc, nickel, and cobalt are completely precipitated, and uranium to a small extent. The metallic zinc deposited from such solutions has a grey colour, and usually a metallic lustre, and is readily soluble in acids and alkalies. Nickel is deposited of a yellowish grey, and cobalt of a reddish grey colour and metallic lustre, and both dissolve with difficulty in cold dilute sulphuric and nitric acids. The original reddish colour of the cobalt solution turns to a dark brown soon after the current begins to operate; a part of the cobaltous oxide is transiently converted into cobaltic oxide. From solutions containing all the three metals the zinc is deposited first.

During the electrolysis of solutions of neutral sulphates of the above metals hydrates are soon formed, in consequence of the conversion of the nitric acid into ammonia, whence such solutions should be previously acidified with acetic acid.

On the electrolysis of the ammoniacal solutions of the above metals, and of the solutions of their cyanides in potassic cyanide, all three metals are completely deposited.

Zinc may also be completely precipitated in a reguline state from the potassic solutions, to which a little potassic cyanide may be advantageously added.

On dissolving in acids the zinc which has been deposited upon platinum there generally remains upon the latter a dark grey coating, rough to the touch, and not soluble even in concentrated acids. On ignition it shows a play of colours which, on subsequent treatment of acids, disappear, whilst some zinc is dissolved. Sometimes it is not practicable to remove the whole of this deposit except by the action of melting acid potassic sulphate. This coating is formed very slightly in potassic solutions, and not at all in the nitrate solutions of zinc.

Manganese is thrown down from its solutions, whether neutral or containing free acid, only as hydrated peroxide, and not at all as a metal. If it is desired that the manganese deposit should adhere firmly to the positive surface the proportion of free acid must be small. In very dilute manganese solutions, containing much nitric acid or a

mixture of nitric and sulphuric acid, permanganic acid is formed, and gives the solution a characteristic red colour.

Uranium is deposited even from perfectly neutral solutions of its oxide only in small quantities and as a yellow-grey metallic precipitate, which dissolves in hydrochloric acid with liberation of hydrogen. In acid solutions uranic oxide is converted into uranous oxide.

Iron is completely deposited in the metallic state from the neutral solutions of ferrous salts. The ferrous oxide is partly converted into ferric oxide in consequence of the oxidising action of the current. If to a neutral solution of ferrous sulphate there is added a solution of ammonic citrate, and if care is taken that a little free citric acid always remains in the solution, the iron is completely thrown down in a shining reguline form, even if a part of it was originally present in the form of a ferric salt. Iron thus deposited resembles bright platinum, but to preserve its lustre it must be washed first in water, then in alcohol, and dried quickly.

From potassic ferrocyanide no metallic iron is precipitated, but Prussian blue at the − pole.

From the solution of ferrous oxide in sodic hyposulphite all the iron is deposited, chiefly as sulphide.

Metallic iron of a blue-grey colour is deposited from the solution of ferrous fluoride in sodic fluoride.

The solutions of the metals of the three first groups present little that is characteristic on the transit of an electric current. If the two poles are arranged separately in the limbs of a U-tube filled with such solutions the hydrates of the metallic oxides appear at the − pole; chromic oxide and aluminic hydrate in a voluminous form; calcic and magnesic hydrates as white incrustations; baric, strontic, potassic, and sodic hydrates in a soluble form.

In the solutions of baric and strontic salts there appear white turbidities on the surface, in consequence of the formation of carbonates. — *Zeitschrift für Analytische Chemie*, Vol. xix., Part i., p. 1.

DETERMINATION OF ACTIVE OXYGEN IN BARIUM BINOXIDE AND IN OXYGENATED WATER.

By M. ARMAND BERTRAND.

For some years the peroxide of barium has become an industrial product, as the dyers employ it in large quantities for bleaching wild silks (as Tussah silk, &c.), and, as well as oxygenated water, it serves for decolourising human hair.

The peroxide is sold in the form of a grey powder, and readily admits of sophistication. The value of a sample is proportionate to the quantity of active oxygen which it contains. This method of analysis is based upon the following reactions:—

$$BaO_2 + 2HCl = H_2O_2 + BaCl_2.$$
$$H_2O_2 + 2KI = K_2O + H_2O + 2I.$$

Hence, 1 grm. iodine corresponds to 43·8355 c.c. of active oxygen at 0° and at the pressure of 760 m.m. The iodine is determined with hyposulphite, without having recourse to starch liquid as indicator.

The standard solutions are:—Iodide of potassium made by dissolving 200 grms. of the pure salt in a quantity of water sufficient to make up a litre. No iodate should be present or the results will be rendered too high. The hyposulphite solution is prepared by dissolving 60 grms. of the pure salt in water and making up to a litre. It is standardised with pure iodine.

Into a large test-glass provided with a foot there are gradually poured 4 to 5 c.c. of pure hydrochloric acid, not containing a trace of free chlorine, which is diluted with water (about 100 to 150 c.c.). Half a gramme of the peroxide of barium, weighed very exactly, is allowed to dissolve in the acid, and 10 c.c. of the solution of potassic iodide is added. Iodine is at once set at liberty. After waiting four or five minutes for the reaction to be complete the hydrochloric acid is saturated with an excess of pure bicarbonate of soda, and the standard solution of hyposulphite is added until the liquid turns from a yellow to a perfect white. This final reaction is very well-defined, so that if the determination is repeated ten or fifteen times on the same sample we obtain constantly the same number of c.c. of hyposulphite, to about 1-10 c.c. Having read off on the burette the number of c.c. of hyposulphite which have been employed, the corresponding weight of iodine is calculated, and thus there is found the value of the sample in free oxygen.

To determine oxygenated water a known volume is taken (a few c.c.), mixed with a dilute solution of hydrochloric acid, and the process is conducted as above directed. —*Moniteur Scientifique.*

ON THE QUANTITATIVE DETERMINATION OF OXYGEN DISSOLVED IN WATER.

By J. KÖNIG.

In No. 14 of the *Berichte* for last year, F. Tiemann and C. Preusse communicated comparative examinations on the methods of determining the free oxygen in water according to the methods of Bunsen, Mohr, and Schützenberger-Risler, and arrived at results opposed to those which the author obtained in concert with L. Mutschler (*Berichte*, x., 2017) They conclude that next to Bunsen's method that of Schützenberger is to be preferred, and that Mohr's method gives too low results, whilst we formerly came almost to the opposite result.

Having been for some years engaged with extensive experiments on the changes undergone by irrigation-water when repeatedly used, I required an exact but speedy method for the determination of the dissolved oxygen, which I felt justified in assuming could not be inoperative in the irrigation of meadows. I was, therefore, along with C. Krauch, engaged with a repetition of the former experiments when the memoir of Tiemann and Preusse came into our hands. Our new results will be given in full in the *Zeitschrift für Analytische Chemie.*

In our former researches we set out with the assumption that the determination of oxygen by Bunsen's method gave absolutely accurate results. For the expulsion and collection of the oxygen dissolved in water we used Reichardt's apparatus. This, however, as we are now convinced, involves an error, and yields too much air and consequently oxygen.

As we then obtained by the Bunsen, Reichardt, and the Mohr process results closely agreeing, and as we were not aware of the source of error above mentioned, the circumstance that Mohr's process yields too much oxygen escaped us. Hence, we must now admit that this method yields uniformly too much oxygen. The result obtained by Tiemann and Preusse we have never been able to confirm in many hundred experiments. The only distinction between our manner of operating and theirs is that we used ammonia instead of soda-lye. As little have we been able to confirm the result of the same chemists that the Schützenberger process is absolutely accurate. On closely following out the method as described by Tiemann and Preusse we find that the results thus obtained fall too low by from ½ to ¼.

After numerous determinations we find that illuminated water (*i.e.*, such as has been exposed to day- or sun-light, like rain-water, or even distilled water which has been aërated by shaking), always yields more oxygen by Mohr's process, as compared with well-water which has been for a length of time withdrawn from the action of light. This may possibly be due to the presence in the former

of oxygenated water (hydrogen peroxide), which has an oxidising effect upon ferrous oxide, but does not act upon sodic hydrosulphite. We must also remark that distilled water, repeatedly shaken up and saturated with air, gives different and rather higher figures for air and oxygen than are admissible according to the coefficients of absorption as calculated by Bunsen. It would therefore seem that the latter cannot be regarded as normal under all circumstances. Otherwise both the Mohr and the Schützenberger process yields results which, though not absolutely, are relatively accurate and respectively comparable, those of the former method being too high and those of the latter too low.

Mohr's process has the advantages that its standard solutions are more permanent, whilst the standard of the hydrosulphite varies from day to day. Mohr's method is therefore recommended where single determinations are required periodically. Schützenberger's is preferred if a large number of samples are to be examined in rapid succession. In the latter case the solution should be standardised not by means of solutions of copper oxide, but with water which is saturated with air by repeated shaking.—*Berichte der Deutsch. Chem. Gesellschaft.*

ON THE

PRESERVATION OF SOLUTIONS OF PALMELLINE.

By Dr. T. L. PHIPSON, F.C.S., &c.

THE solution of Palmelline obtained by allowing cold water to stand for a day or two over the air-dried plant (*Palmella cruenta*), as described in my account of this substance last autumn, like all solutions of albuminoid substances, is very subject to decomposition, and at temperatures of 75° to 80° F., putrefaction sets in rapidly. The beautiful rose and yellow dichroic tint of the solution becomes paler and finally disappears, whilst the liquid takes a strong ammoniacal odour and swarms with *bacterium, vibrio, and spirillium.* The latter are not easily to be distinguished (except by their small size and that their motion is more rapid) from the spirillium which is present in the blood in cases of relapsing fever, during the pyrexia only, disappearing as the temperature of the body falls.

I have tried various methods of preserving the liquid in question without altering its composition and optical properties. Exclusion from air and light were only partially successful for short periods. The addition of a little salicylic acid modifies the delicate purple-rose tint and destroys the dichroism, so that the orange-yellow is no longer seen by reflection; moreover, it only preserves the liquid for a week or two, after which the phenomena alluded to set in as above described. Finally, I found that ether, which has no solvent action on Palmelline and does not affect its composition nor coagulate it, may be used with success to preserve the liquid for an indefinite period. It is sufficient to add a small quantity of ether to the solution in a tube, cork it, and turn it over once or twice so as to dissolve as much ether as possible in the liquid, to preserve it with all its properties for several months. As long as the contents of the tube have a strong odour of ether no decomposition sets in, and the optical properties of the palmelline remain intact.

This simple method of preservation may be found applicable to many other organic substances upon which ether exerts no chemical action.

Putney, April 24, 1880.

Physical Society.—Sir William Thomson will preside at the meeting on Saturday afternoon, the 8th, and will make some brief communications.

NOTICES OF BOOKS.

The Tar-Colour Works of Messrs. Meister, Lucius, and Brüning, at Höchst on the Main, in a Sanitary and Social Point of View. (Die Theerfarben-Fabriken der Herren, Meister, Lucius, und Brüning, zu Höchst am Mein, in Sanitärer und Socialer Beziehung.) By Dr. GRANDHOMME. Berlin: L. Schuhmacher. (Reprinted from *Eulenberg's Vierteljahrschrift für Gericht Medicin und Œffentl. Sanitats wesen*, N. S., xxxii.)

WE have here a most valuable contribution to sanitary science. The manufacture of coal-tar colours has brought into use on the large scale a number of chemical compounds whose physiological action has been very imperfectly known. In consequence the most contradictory and highly-coloured statements have been circulated in political and literary organs. Many of the new colours have been denounced as exceedingly dangerous, not merely to the makers and to the dyers and printers who apply them to the textile fabrics, but even to the wearers of such tissues. There has been no due distinction observed between the properties of the raw materials and those of the finished products, and dyes have been condemned as poisonous in virtue of impurities resulting from imperfect and now obsolete methods of manufacture.

Under these circumstances all persons connected with the tinctorial trades may congratulate themselves on the appearance of the present work. The far-famed establishment of Messrs. Meister, Lucius, and Brüning offers opportunities for the study of the question not to be met with elsewhere. It employs over 1000 workmen, besides 40 foremen and managers, 25 chemists, 1 engineer, and 30 clerks. Everything is conducted in the most systematic manner. Each class of colours is prepared in separate work-rooms: thus we read of the blue house, the violet house, the eosin and the naphthol houses, &c. A stringent rule provides that no workman may enter any part of the establishment save his own department. A very close watch is kept upon the health of all persons employed, and—a very important feature—the use of arsenic in the manufacture of magenta has been abandoned in favour of Coupier's process. There is consequently no danger that the physiological action of magenta and its derivatives may be complicated by arsenical impurities. Every precaution is taken to obviate dangers; the arrangements for ventilation are very complete. Any apparatus giving off noxious gases is placed in connection with the chimney. Rooms containing combustible and explosive materials are illuminated solely by the electric light on the principle of Siemens and Halske.

Among the raw materials benzol, naphthalin, and anthracen have been carefully examined as regards their action upon human health. Benzol is admittedly poisonous. It has repeatedly proved fatal when experimentally administered to animals. If the vapour is inhaled by man it produces irritation of the nervous centres, dizziness, ringing in the ears, nausea, and drowsiness. Only one serious case is recorded in medical literature, which, however, terminated in recovery.

Naphthalin is not to be feared, except in the state of very hot vapour. If taken internally it irritates the stomach, but none of the experiments made upon animals have had a fatal result.

Anthracen has an irritating action upon the mucous membranes, but it has not proved injurious to the workmen.

Nitrobenzol has been made the subject of extended experiments. as well as of clinical observations. The symptoms produced are difficulty of breathing, dizziness, drowsiness, tonic and clonic convulsions; but death often occurs from general paralysis. These morbid phenomena sometimes do not commence until after twenty-four hours have elapsed. Medical literature records forty-four cases of acute poisoning in human subjects, fourteen of which

proved fatal. The possibility of a chronic or cumulative action is not decided. No case of sickness from nitrobenzol has occurred at Höchst, though of the eight men in this department one has been employed for six years, one for eight, two for nine, and one for ten years.

The poisonous nature of aniline, including both the pure base and the so-called aniline-oil of commerce, is indisputable. Many recorded clinical observations are untrustworthy, as it does not appear whether the poison was raw aniline or some of its derivatives contaminated with arsenical or mercurial compounds. Three cases of "anilism" have been observed among the thirteen workmen employed in this branch.

Contrary to a very general opinion, rosaniline and its salts prepared without arsenic have been found harmless. The urine of the men employed in the magenta house has been specially tested for albumen, but with a negative result. Eczema and erythema do not occur among the workmen. Dr. Grandhomme considers that the irritation of the skin said to have frequently arisen from the use of stockings, &c., dyed with magenta is doubtless a consequence of the presence of arsenic. The derivatives of rosaniline, aniline-blue, violet, green, &c., are also harmless.

Eosin and erythrosin produced no injurious symptoms when taken by rabbits. The workmen in the eosin house, however, did not enjoy good health. Of seventeen persons employed in this department sixteen are annually unwell, chiefly from *hyperidrosis localis*.

The naphthol colours are not to be regarded as dangerous, the cases of illness in this department being chiefly due to slight wounds.

In the alizarin house the most prevalent diseases were affections of the skin, concerning the origin of which the author is not yet satisfied.

In the entire establishment the cases of illness which could in any way be traced to the nature of the employment formed only 3 per cent of the total cases. Hence it may well be questioned if the manufacture of coal-tar colours can be regarded as a specially dangerous employment.

This work is strongly to be recommended to the notice of medical practitioners, especially in the manufacturing districts. If writers and lecturers who wish to organise a crusade against poisonous colours will consult Dr. Grandhomme it will enable them to add knowledge to their zeal.

Agenda du Chemiste. Paris: Hachette et Cie.

This work, which appears with a recommendatory preface from no less eminent an authority than Prof. Würtz, seems to have taken its origin from a manuscript collection of notes and memoranda which had been gradually formed in his laboratory. Being continually consulted by his pupils and assistants, the thought occurred to the latter, some of whom have already made themselves very honourably known, that it might be found no less useful to chemists in other laboratories,—in fact, to the profession in general. The result of this happy idea was the publication of the present *multum in parvo*, in the form of an annual pocket-book. It would be difficult indeed to condense a larger amount of information, especially useful to the chemist, into so small a compass.

The first chapter is devoted to "Physical and Mathematical Documents," comprising the conversion of old or foreign measures and weights into the modern French standards; tables of circumferences, circles, squares, cubes, square roots, and cube roots, from 1 to 100; comparison of different thermometric scales; reduction of the indications of the mercurial thermometer to the temperatures shown by an air thermometer, and correction of thermometers. We have next a table of the coefficients of the linear expansion of certain solids, from 0° to 100°; of the cubic expansion of mercury and of glass; and of the expansion of certain liquids. Upon this follow sections on barometry, on vapour tension, the liquefaction of gases, and their vapour tension in that state. Next we come to specific gravity, where are comparisons of the different hydrometric scales, tables of the specific gravities of inorganic compounds and minerals, of gases and vapours, and of solutions. We have next a series of tables not generally to be met with in manuals, such as the specific gravities of mixtures of alcohol and ether, of methylic alcohol and water, of bromine water, of solutions of hydrobromic and hydriodic acids; of fluosilicic, iodic, periodic, phosphoric, and arsenic acids; of the formic, tannic, oxalic, tartaric, and citric acids; and of series of saline solutions which we have not even room to particularise.

Under the head of Heat we find not merely refrigerating mixtures, but tables of the calories liberated in the mutual reactions of the non-metallic bodies; formation heats of salts, and other thermo-chemical data.

Under Light we find tables of indices of refraction, and of the rotatory powers of solids and liquids.

The second chapter, which is devoted to pure chemistry, deals with qualitative analysis in the moist way; by means of the blowpipe; spectral analysis; quantitative analysis, with table of factors for the calculation of results; tables of the formulæ of the most important compounds, with their solubilities in cold and boiling water and in concentrated alcohol.

The third chapter relates to industrial and applied chemistry, and is no less rich in well-selected facts, figures, and condensed instructions than are the two preceding.

The principal deficiency of the book is the want of a good index, a feature especially needful in a work of reference, and which the brief table of contents can by no means supply.

In the instructions for the analysis of superphosphates the reader is directed to determine the *sulphuric* acid in the aqueous solution by means of uranium. This is doubtless a clerical or typographical error for the *phosphoric* acid. In the preparation of "magnesia-mixture" we would venture to recommend magnesium chloride as preferable to the corresponding sulphate.

In the table of the percentages of tannin in different astringent materials we should suggest a re-consideration of the very low figure—12 per cent—ascribed to divi-divi. Its comparative action in dyeing blacks along with a salt of iron would place it above 30 per cent.

We may best sum up our opinion of this little Manual by declaring that no chemist ought to be without it, especially as a very slight knowledge of the French language will enable the reader to make use of its contents. The student, the commercial analyst, and the investigator engaged in purely scientific researches will all find it a valuable guide and a great saving of time and trouble, and all of them have good reason to be grateful to the compilers, and especially to M. Salet, upon whom the editorial duty has, we believe, exclusively rested.

Ceylon Coffee Soils and Manures. A Report to the Ceylon Coffee Planters' Association. By John Hughes, F.C.S. London: printed by Straker Bros. and Co.

The planters of Ceylon have to contend with difficulties not few. The *Hemileia vastatrix* is not unworthy to rank with the *Phylloxera* and the *Pteronosphora infestans*; white bugs and Termites commit depredations on the coffee-trees; the estates, lying often on steep declivities, are robbed of the richest portion of their soil by the heavy tropical rains, and judicious manuring of land regularly under crop has been the exception rather than the rule. It is therefore not surprising that the Coffee Planters' Association should become convinced of the necessity of obtaining scientific advice, and should engage a competent agricultural chemist to examine and report upon their soils and the means for their improvement.

Mr. Hughes appears to have inspected the coffee-growing districts, noticed their deficiencies and their capabilities, and examined the articles chiefly used as manure. As a matter of course, in a country where roads are bad and

transport necessarily costly, only the most concentrated fertilisers can be recommended. Mr. Hughes further points out that, in a tropical climate like Ceylon, manures, and even lime, should be applied in small successive doses. He finds Australian bone-dust contains a larger percentage of organic matter than that of Indian origin, but such matter is in the former case poorer in nitrogen. The Ceylon coffee-soils he finds generally deficient in phosphoric acid as well as in lime. Of the latter requisite of plant-food the coral-beds on the coasts of the island yield a satisfactory supply, which will become more available as the roads are improved. As a source of phosphoric acid he recommends steamed bones and superphosphates; but he does not seem to have thrown any light upon the possible presence of phosphatic minerals in Ceylon. Such deposits are of the greater moment as the bone-exporting countries of the world must, with the progress of cultivation, become fewer and fewer. If Australia and the mainland of India advance in the direction that is to be hoped, their bones will be needed for return to the soil whence they were drawn.

Nitrogen, Mr. Hughes thinks, should be supplied to the soil rather in the state of organic insoluble matter than as ammoniacal salts, or as nitrates, which are liable to be washed away before they can be absorbed by the roots of the trees. For the same reason he contends that potash, notwithstanding its predominance in the ash of the coffee-berry, should not be supplied in large quantities. He argues, also, that plants possess the power of abstracting potash from the soil to a much greater extent than they do the other important mineral elements. Admitting this power, still so long as a soil contains merely a finite supply of potash it must ultimately become exhausted by crops which absorb it to a considerable extent. The proportion of 4 per cent of potash, which Mr. Hughes would allow in coffee manures, is, however, one which we should not feel disposed to exceed.

Coffee cannot, however, be considered an exhausting crop. Taking 7 cwt. per acre as a very full average crop, and making the necessary additions for the pulp and the leaf, Mr. Hughes finds that the total amount of mineral matter removed yearly from the soil is but 60·2 lbs., as against 364 lbs. in the case of turnips, and 189 lbs. in the case of wheat.

"Carbonate of lime," the author remarks, "as a constituent of manufactured manures in England, would have decidedly a low value." Should not it be rather regarded as a negative quantity?

It has, we believe, been objected that Mr. Hughes, though pointing out many errors to be avoided, does not state with sufficient distinctness what is the best course to follow. We can scarcely admit this censure. He does not, indeed, lay down one universal formula to be applied under all circumstances, for the sufficient reason that no such universal remedy is possible; but those who mix their manures "with brains," as a certain eminent artist said of his colours, will find here most useful indications.

Incidentally the author notices a kind of tea made from the leaves of the coffee tree. It had a "somewhat strong flavour and slight medicinal taste."

CORRESPONDENCE.

AMMONIA FROM ATMOSPHERIC NITROGEN.

To the Editor of the Chemical News.

Sir,—I thank J. B. T. for pointing out to me that I can now obtain a copy of the complete specification of Rickman and Thompson's patent, and I have written for it.

Meanwhile I beg to call J. B. T.'s attention to some of his statements, which are evidently inaccurate as far as percentage of N usually contained in coal is concerned. The instances he quotes are the exceptions, while, as a rule, coal contains on the average 1½ per cent of N, some even over 2 per cent. I cannot do better than refer J. B. T. in this respect to a series of analyses by Dr. Lyon Playfair, given in "Muspratt's Chemistry."

If Messrs. Rickman and Thompson have been working with coal containing as little as 0·36 to 0·39 N and have obtained the splendid result stated, such facts are all the more to the credit of their patent, but still I am puzzled and unable to understand how they obtain sufficient atmospheric nitrogen when in the provisional specification the following sentence occurs: "We expose the mixture to moderate heat in a slow burning furnace, supplying the furnace *with a small amount of air*," &c.—I am, &c.,

J. H.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 13, March 29, 1880

Determination of High Temperatures.—H. Sainte-Claire Deville and L. Troost.—One of the authors announced in September, 1878, that the measurement of elevated temperatures had been effected by means of the apparatus which they employed for the determination of the coefficient of expansion of porcelain simplified by the use of Sprengel's pump, which renders it possible to remove and measure when desired the thermometric matter (nitrogen) contained in the reservoir, and to calculate its temperature. The instrument and the manner of using it are described at length.

Researches on Diffusion.—L. Joulin.—These researches refer to the condensation of gases by porous bodies, the solution of gases in liquids, either on direct contact or when separated by a membrane, and the equilibria established between gases condensed or dissolved and a limited ambient atmosphere. In case of each of these phenomena the author has studied the influence of the pressure of gases varying from a few centimetres of mercury to 4 atmospheres, and at temperatures varying from 0° to 100°.

A New Property of the Vanadiates.—P. Hautefeuille.—The acid vanadiates of potassium, sodium, and lithium, when passing slowly from a liquid to a solid state, behave like silver under the same circumstances, emitting fine bubbles of gas and producing a sound resembling the decrepitation of common salt. The gas emitted is oxygen which has been absorbed from the atmosphere. If the true vanadic acid, the isomorph of phosphoric acid, is a body capable of combining without loss of weight with bases, and in particular with lithium, it contains per gramme 8·3 milligrms. less oxygen than vanadic acid which has been melted or dried in the air. As the equivalent of vanadium has been determined by the loss of weight which vanadic acid undergoes in passing to the state of vanadium teroxide, the author is preparing for a re-examination of this method.

Certain Properties of Mixtures of Methyl-cyanide with Common Alcohol and Methylic Alcohol.—MM. Camille Vincent and Delachanal.—In order to separate methyl-cyanide from vinic alcohol the mixture is first submitted to fractional distillation in order to classify the products. The largest possible quantity of calcium chloride is then made to dissolve in the liquid boiling at the lowest possible temperature, so as to absorb the alcohol. The whole is then distilled in the water-bath, and the product once more submitted to fractionated distillation

No. 14, April 5, 1880.

Determination of High Temperatures.—H. Sainte-Claire Deville and L. Troost.—The authors have studied the boiling-points of zinc and cadmium by means of the air-thermometer, and their determinations agree closely with those published by E. Becquerel. The boiling-points of zinc increase successively when hydrogen, air, and carbonic acid are used as the thermometric material. Although carbonic acid gives a boiling-point much higher than the other gases, the authors do not feel as yet warranted in ascribing the excess of volume to dissociation. One of them is about to undertake experiments with a view of finding the causes of the differences observed on employing the vapour of iodine instead of air as a thermometric material.

The Formation-heat of the Oxides of Nitrogen.—M. Berthelot.—For the protoxide the author gives the number −10·3; for nitric oxide, −21·6; nitrous acid, −11·1; hyponitric acid, −2·6; liquid, +1·7; nitric acid, −0·6; liquid, +1·8; solid, +5·9; dissolved, +14·3.

Continuous Gyratory Movements Produced by a Rotative Induction-machine.—W. de Fonvielle and D. Lontin.—The magnetic gyroscope of the authors cannot be intelligibly described without the accompanying figures.

Measurer of Energy.—Marcel Deprez.—Among the uses of this instrument the author states that it will show the quantity of heat necessary to effect a chemical decomposition. The graduation may show either calories or kilogrammetres or horse-powers. If applied to an electric lamp it shows at each instant the work absorbed by the production of light.

The Specific Heat and the Conductibility of Bodies.—M. Morisot.—A mathematical paper, not susceptible of useful abstraction.

Sulphides and Selenides of Chrome.—H. Moissan. The author has obtained the sesqui-sulphide by exposing chromic sesqui-oxide, anhydrous but not calcined, to a current of dry sulphuretted hydrogen at the temperature of 440°. It is of a dark maroon colour, and is not readily attacked by acids, except the nitric and *aqua regia*, which dissolve it. If kept at a high temperature in a current of hydrogen it is converted into the monosulphide. The corresponding selenides are obtained in an analogous manner.

Thermo-chemical Study of the Earthy Sulphides.—P. Sabatier.—The sulphides in question are those of magnesium, aluminium, and silicium.

Crystalline Oxalic Acid.—A. Villiers.—The author has succeeded in obtaining the normal acid, $C_4H_2O_3$, in very fine octahedral crystals, by dissolving small quantities of ordinary oxalic acid in concentrated sulphuric acid, the latter being in large excess. Oxalic acid is almost as greedy of water as is sulphuric acid, and can even take away moisture from the latter when in a dilute solution.

Amidic Acids of α-Oxy-caproic Acid.—E. Duvillier.—An account of the methyl-amido-α-caproic acid and of the corresponding ethylic compound.

Proportion between the Sugar and the Mineral and Nitrogenous Substances in Beet-root.—H. Pellet.—The order of utility of manurial elements for the beet-root is as follows:—Phosphoric acid, magnesia, lime, then follow potash and soda, and lastly nitrogen. The formulæ calculated from the author's researches agree very closely with those indicated fifteen years ago by M. G. Ville.

Simultaneous Reproduction of Orthose and Quartz.—P. Hautefeuille.—Phosphates employed along with fluorides render it possible to reproduce minerals belonging to different species, not only separately, but associated together as they are found in their natural beds.

Chemisches Central-blatt.

No. 6, 1880.

The matter in this number has been noticed elsewhere.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.

No. 1, 1880.

On a Series of Aromatic Bases Isomeric with the Oils of Mustard and the Sulphocyanates.—A. W. Hofmann.—This long and important paper is not susceptible of useful abstraction.

Synthetic Formation of Formic Acid.—V. Merz and J. Tibiriça.—Various syntheses of organic bodies from inorganic materials are known, but at present it would be scarcely possible to prepare in this manner, on the large scale, any organic substance capable of an industrial application. As a first step in this direction, experiments with carbon oxide or dioxide seem to offer an especial interest. As it is well known these oxides have both been transformed into the first member of the series of the fatty acids, *i.e.*, formic acid. The earlier syntheses of this acid, by H. Kolbe, R. Schmidt, Maly, and Berthelot, are not capable of yielding the acid to any great extent. The authors caused carbon oxide to pass slowly over ordinary soda-lime at temperatures from 180° to 200°, and obtained formiates in abundance. The salt must be loose in texture, the gas moist, and the temperature must not exceed 220.°

A New Base.—E. F. Smith.—The base in question, $C_{21}Cl_{26}$, was obtained by the complete chlorinisation of toluol. When pure it forms large colourless prisms, fusible at 152° to 153°.

Products obtained by Nitrising Metachlor-salicylic Acid.—E. F. Smith and G. K. Peirce.—On nitrising metachlor-salicylic acid the authors obtained two products which they distinguish as A and B. The former is a crystalline mass which separates in long reddish needles, and is resolvable into two compounds. B is an acid, probably identical with that described by Hübner.

On Normal Propyl-alcohol from Glycerin.—A. Fitz.—The author has obtained this compound as a product of fermentation.

On the α and β Position in Naphthalin.—F. Reverdin and E. Noelting.—Already noticed.

Products of the Sulphurisation of Isomeric Nitramido- and Diamido-benzols.—Jul. Post and E. Hardtung.—Among the compounds obtained and examined are ortho-nitramido-sulphi-benzol with some of its salts, ortho-diamido-sulphi-benzol, and meta-nitramido-sulphi-benzol.

Detection of Alizarin, Isopurpurin, and Flavopurpurin when they occur simultaneously, and on the Quantitative Determination of Alizarin.—E. Schunck and H. Roemer.—Already noticed.

On Certain Azo-Compounds.—J. H. Stebbins.—The author obtains azo-benzol-trinitro-oxybenzol by the action of 1 mol. picric acid in alcoholic solution upon 1 mol. diazo-benzol nitrate. Azo-benzol-pyrogallol is obtained by the action of 1 mol. of pyrogallol in an alkaline solution upon 1 mol. of diazo-benzol nitrate.

A Lecture Apparatus.—H. Schulze.—This paper requires the accompanying illustrations.

A Synthesis of Cumol.—A. Liebmann.—The author obtains cumol by the action of benzol-chloride diluted with six volumes of anhydrous ether upon zinc methyl at a gentle heat.

The Third Anthracen Mono-carbonic Acid.—C. Liebermann and A. Bischof.—Not suitable for abstraction.

Composition of Weldon Mud and Similar Compounds (Second communication).—Jul. Post.—The author gives several analyses of the mud in different states. He does not consider the question of the existence of a manganous acid as decided.

Contributions to a Knowledge of the Spontaneous Oxidation of Manganous Hydroxide with Reference to the Regeneration of Manganese.—Jul. Post.—A continuation of the memoir begun in *Berichte* (xii., 1537), and not susceptible of useful abstraction.

Action of Sulphuric Acid upon Phosphates, especially Calcium Phosphate, with Reference to the Manufacture of Superphosphate.—Jul. Post.—The author's experiments, which are still in progress, lead him to the opinion that on the action of 2 mols. sulphuric acid upon 1 mol. tricalcic phosphate the equivalent proportion of phosphoric acid is first set free, and then acts upon the unattacked tricalcic phosphate.

On Mono-phenyl-borchloride and the Valence of Boron.—A. Michaelis and P. Becker.—The authors consider the pentavalence of boron highly probable, though not formally demonstrated.

Carbon Acids of Pyridin.—S. Hoogewerff and W. A. van Dorp.—Since the discovery of pyro-cinchomeronic acid the three monocarbo-pyridic acids which are possible, in accordance with Körner's formula for pyridin, are known, since both nicotic and picolic acid are known as such.

Studies on the Compounds obtained from Animal Tar.—H. Weidel and G. L. Ciamician.—In this communication the authors describe the non-basic compounds. In their general summary of the bodies they obtained they mention, as the chief products, nitriles of the butyric, valerianic, capronic, isocapronic, caprinic, palmitic, and stearic acids; further, pyrrol, homo-pyrrol, dimethyl-pyrrol, and hydrocarbons of the composition C_9H_{14}, $C_{10}H_{16}$, $C_{11}H_{18}$. As by-products there appear pyridine, picoline, lutidine, chinoline, phenol, propionitril, valeramid, toluol, ethyl-benzol, and naphthalin.

Action of Potassium Ferricyanide upon Morphine.—Karl Polstorff.—The author has obtained by this reaction oxydimorphine, $C_{34}H_{36}N_2O_8+3H_2O$.

On Schützenberger's Oxymorphine.—K. Broockmann and K. Polstorff.—Both the free base and its salts agree in their properties with the oxydimorphine described in the foregoing paper.

Action of Potassium Permanganate upon Morphine.—K. Broockmann and K. Polstorff.—Oxydimorphine was here also obtained.

Action of Atmospheric Oxygen upon Morphine in an Ammoniacal Solution.—K. Broockmann and K. Polstorff.—Here also oxydimorphine was obtained.

Action of Potassium Ferricyanide upon Methyl-morphine Iodide.—K. Polstorff.—The author obtained basic methyl-oxydimorphine iodide, a corresponding neutral salt, and methyl-oxydimorphine hydroxide.

On Methyl-morphine Hydroxide.—K. Broockman and K. Polstorff.—The authors have isolated this compound in a state of purity.

Action of Benzoyl-chloride upon Morphine.—K. Polstorff.—Three benzoyl groups are introduced into the morphine.

On Acridin.—C. Graebe and H. Caro.—This memoir does not admit of abstraction.

On Artificial Alkaloids.—A. Ladenburg.—The identity of natural and artificial atropine is demonstrated both by their chemical and physical attributes and by their physiological effects.

Revue Universelle des Mines, de la Metallurgie, &c., Tome 6, No. 3, Nov. and Dec., 1879.

Electric Lighting.—H. de Backer.—An account of the rise and progress of electric lighting, with especial notices of the machines of Meritens, Deprez, Lontin, Gramme, Hofener-Alteneck; the regulators of Jaspar, Gaiffe, Carré, Serrin, Lontin, Mersanne; the Jablochkoff and the Wilde candles; the lamps of Regnier and Werdermann, &c. We do not find any notice of the improvements of M. Tommassi, which is surely an omission.

The Royal School of Mines, of London.—A. Ronna.—The author denounces the removal of the chair of Metallurgy from Jermyn Street to South Kensington, and the resignation of Dr. Percy, and gives at length the solemn protest of this distinguished metallurgist.

The "Pantelephone" of Locht.—The author figures and describes a new instrument which he has constructed, and which is free from the defects of previous telephones.

The Influence of Air in the Reduction of the Ores of Zinc.—J. Binon.—The author shows that the presence of air is mischievous, by decreasing the points of contact between the ore and the fuel, and thus impeding reduction.

Suppression of Animal Charcoal in the Sugar Manufacture.—V. Francken.—M. Meyer substitutes for bone-black silica prepared in a peculiar manner, which is not described, but which is said to give very satisfactory results.

Moniteur Scientifique, Quesneville. February, 1880.

A New Process for the Separation of Nickel and Cobalt.—Ph. Dirvell.—Inserted at length.

The Extraction of Perfumes by means of Methyl Chloride.—Camille Vincent.—Already noticed.

Methylated Products and the Preparation of Pure Methylic Alcohol.—M. Bardy.—A report presented to the Société d'Encouragement on the result of the author's researches on the applications of methylene in the manufacture of coal-tar colours, and on a new process for obtaining methylic alcohol, as also on methods for the analysis of mixtures of vinic and methylic alcohols.

NOTES AND QUERIES.

Portland Cement.—Will Mr. Watson please to give the formula of the double silicate of alumina and lime which the materials for Portland cement should be proportioned to produce, and oblige.—Portland Cement.

Condensation of Ammonia.—Can any of your readers assist me in the following? In submitting to heat a mixture of sulphate of ammonia or sal-ammoniac and chalk, there result sesquicarbonate of ammonia, and also a determinate quantity of free ammonia and water, which latter (NH_4O) it is of course necessary to preserve, in order to conduct the process economically, and on this point none of the text-books I have read give any detail. Any information you could give me as to a ready, efficient, and inexpensive method of collecting this free ammonia in water to be subsequently reconverted into sulphate or chloride will be highly appreciated.—A Constant Reader.

MEETINGS FOR THE WEEK.

Monday, 10th.—Society of Arts, 8. Robert W. Edis, F.S.A., "The Decoration and Furniture of Town Houses."
—— Royal Geographical, 8.30.
Tuesday, 11th.—Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Photographic, 8
—— Anthropological Institute, 8.
—— Royal Institution, 3. Mr. R. H. Scott, 'Wind and Weather."
Wednesday, 12th.—Society of Arts, 8. Mr, Charles Wood, "Utilisation and Properties of Blast Furnace Slag."
—— Geological, 8.
—— Microscopical, 8.
Thursday, 13th.—Royal Institution, 3. Prof. Tyndall, "Light as a Mode of Motion: Theories of Light and Colour."
—— Royal Society Club, 6.30.
—— Royal, 8.30.
—— Society of Arts, 8. Prof. W. G. Adams, F.R.S., "The Optical Properties of Crystals and some of their Practical Applications."
Friday, 14th.—Royal Institution, 8. Lord Reay, "Certain Aspects of Social Democracy in Germany," 9.
Astronomical, 8.
—— Quekett, 8.
—— Clinical, 8 30
—— Society of Arts, 8. A. Terrien de la Couperie, "China and the Chinese: Their Early History and Future Prospects."
Saturday, 15th.—Royal Institution. Prof. Morley, "The Dramatists before Shakespeare," 3.

TO CORRESPONDENTS.

Joseph Hemingway.—Mr. A. H. Allen's "Introduction to the Practice of Commercial Organic Analysis" is the most suitable. We do not know of any work which deals with oils and soaps alone.

Will Messrs. Fickman and Thompson, who have just taken patents for the production of ammonia from the nitrogen of the atmosphere, kindly forward their address to our Office.

THE CHEMICAL NEWS.

Vol. XLI. No. 1068.

ON THE

DETECTION OF STARCH SUGAR MECHANICALLY MIXED WITH REFINED CANE SUGAR.*

By P. CASAMAJOR.

About a year ago we were often entertained by the daily press with accounts of the adulterations practised by sugar refiners, and, among these adulterations, the one most generally used, as we were then told, was the mixing of refined sugar with starch glucose. I must confess that I never believed in such a practice; for, although I had tried to procure specimens of such sugars, I was not able to find any, and one or two specimens which were given to me, as of sugar so adulterated, turned out to be pure, as far as the presence of starch sugar was concerned. The idea that these sugars were so adulterated very likely originated in the imperfection of the processes used to detect the presence of starch sugar.

This week, however, I have had the good fortune to come in possession of a sample of refined sugar largely adulterated with starch glucose. This sample was sent to Messrs. Havemeyer and Elder from St. Louis, and a slip of paper in the box gave the information that the barrel from which this sugar was taken was marked "Powdered Sugar, Manhattan Sugar Refinery, New York;" a refinery of the existence of which I have not been able to find any proof.

The incredulity which I previously maintained on the existence of adulteration by starch sugar was based on the following considerations:

From a sugar solution you can only obtain, by the ordinary processes of a refinery, a quantity of crystallised sugar representing very nearly the difference between the cane sugar present and the soluble impurities. If you have, for instance, a sugar solution whose co-efficient of purity is 90 per cent the soluble impurities will represent 10 per cent of the total of the substances in solution, and you can obtain, at the utmost, only 90 − 10 = 80 parts of sugar from 100 parts of substances dissolved. Processes have been published whereby a greater yield may be obtained, but such processes require the use of alcohol or of large quantities of salts of magnesia, and they have never been used in any extended scale. As starch sugar in solution does not act otherwise than any other impurity in solution, the addition of it in a dissolved state to a sugar solution could not have any other effect than to diminish the yield of sugar and increase that of molasses.

The only manner in which starch glucose can be mixed with refined cane sugar, so as to give a profit, instead of a loss, to the person effecting this mixture, is to mix the two substances in a solid state. Now, the starch sugar must either be added in large quantities—and then it seemed to me that it could be easily detected by the eye or by the taste; or it must be added in very small quantities, and then the difference between the price of sugar and that of starch glucose would not leave a profit proportional to the trouble. My experience with sugar refiners does not lead me to believe that the refiner exists who would adulterate his products by adding to them only one or two per cent of starch glucose. Such a thing would not pay.

The object of this communication is to give a few easy processes for the detection of starch glucose in commercial sugar.

By the use of the optical saccharometer, the presence of starch sugar may be easily detected, when in quantities as large as in the sample in question. It is a dextro-gyrate substance, and no other dextro-gyrate substance could be used to adulterate sugar with efficiency in such large quantities.

The direct test by the optical saccharometer gives 97 per cent. After inversion, the reading of the saccharometer is 9·8 per cent to the left at 21° C. If we add these numbers we find by Clerget's table that they correspond to 80 per cent of cane sugar. As the sugar is dry, the balance, 20 per cent, nearly represents the quantity of starch sugar, as from the appearance of the sugar there must very little inverted sugar present.

I need not now consider the subject of inversion as a means of ascertaining the actual quantity of cane sugar present in a sample of commercial sugar, as I have already had occasion, in a paper read before this Society at our regular meeting of February of last year, to discuss this subject at great length.* I may, however, say that if this sugar had been what we call in the sugar business a *straight sugar*, 97 per cent of sugar, after inversion, would have given at 21° C. − 32·5°, instead of −9·8°. I call attention to this to show of what precious help the process of Clerget is in cases of this kind. It is a sad truth that very many persons, whose occupation is the analysis of sugars, are either entirely ignorant of the process of Clerget, or do not know enough about it to use it when they need it.

This sugar, tested by the alkaline copper solution, gives 17 per cent of reducing substances calculated as glucose, which shows that the starch sugar mixed with refined sugar contained $\frac{17}{20}$=85 per cent of these reducing substances.

The process which I had the honour of describing before this Society at our June meeting† gives unsatisfactory results with sugar adulterated by starch glucose. This is due to the imperfect solubility of starch glucose in methylic alcohol. After grinding the sugar under examination with the standard solution for three minutes, the process gave 85 per cent of pure sugar—a discrepancy from the result by the saccharometer (80 per cent) which never takes place with straight sugars.

Besides these processes, which can only be applied by persons provided with scientific appliances, the presence of starch glucose, when used in such large quantities, may be readily detected by very simple processes, which may be applied by any body who wishes to use such means as are always at hand.

One process for the detection of starch glucose consists in adding to the suspected sugar somewhat less than its own weight of cold water and stirring for a few seconds. If starch sugar is present, it will be seen floating in the solution as white specks which resemble crushed wheat. This appearance is due to the comparative insolubility of starch glucose in cold water, which allows it to remain undissolved quite a long time, and also to the fact that as the cane sugar present is crystalline, and its refrangibility is not very different from that of a sugar solution, the portion of it which remains undissolved is not so distinctly seen as the specks of starch sugar. These specks are best seen by using a beaker glass, and putting only enough sugar and enough water that we may be able to see light through the flat bottom of the glass. If a flat-bottomed glass is not at hand, the observation may be made on a pane of glass.

This process for the detection of mixtures of starch

* A Paper read before the American Chemical Society, March 4, 1880.

* See *Journal of the American Chemical Society*, vol. i. p. 26; also Chemical News, vol. xxxix., pp. 212—234, *Sugar Cane*; vol. xi., p. 296; *Moniteur Scientifique*, Juin, 1879, p. 647; *Stammer's Zeitschrift*, Juli, 1879, p. 683.

† See *Journal of the American Chemical Society*, vol. i., p. 205; also Chemical News, vol. xl., pp. 74, 97, 107, 131; *Sugar Cane*, vol. xi., pp. 531, 588, 693; *Zeitschrift des Vereins*, October, 1879, p. 957; *Ann. de Chemie et de Phys.*, 5th series, vol. 18, p. 559.

glucose with cane sugar is so simple and satisfactory that I might well be excused from giving another, but the one I am about to give is useful for the detection of other foreign substances in the products of refineries. This process is based on this, that the taste of sugar has a tendency to dull our perceptions of the taste of other substances mixed with sugar. So as to neutralise this effect of sugar, we may, before tasting a suspected sample, put a pinch of pure sugar in the mouth. If after this sugar is dissolved, but while we still perceive its sweet taste, we put on the tongue a pinch of sugar containing starch glucose we distinctly perceive the bitterish taste of the glucose.

This process is very useful for detecting other foreign matters besides starch sugars. The presence of chloride of tin in molasses or sugars, even when used in very small quantities, can be easily detected by its unpleasant bitter taste if, before tasting the suspected products, we fill the mouth with the pure sweet taste of refined cane sugar.

VOLUMETRIC DETERMINATION OF PHENOL.

By P. DEGENER.

On adding bromine water to a liquid containing phenol there is precipitated tribromo-phenol, which, under the circumstances of the experiment, is not attacked by an excess of bromine. Upon this reaction the author bases the following volumetrical process:—Standard bromine water is gradually added to a solution of phenol sufficiently diluted, preferably containing less than 1 per cent. The end of the reaction—that is, the moment when the liquid contains a trace of free bromine—is determined by means of a starched potassium iodine paper. This final reaction is very distinct; and if the liquid under examination is colourless, the least excess of bromine may be detected by the yellowish tint which it communicates.

The author employs a solution containing 40 grms. bromine and 20 grms potassium bromide in a litre of water. It is standardised by means of a solution of pure phenol, an operation which must be repeated daily, as bromine water quickly loses strength. The solution of phenol itself is not permanent, so that it is preferable to determine the value of the bromine solution by an iodometric process.—*Journal für Praktische Chemie.*

ON THE DETERMINATION OF CHROMIUM.

By THEODOR WILM.

By occasion of numerous determinations of chromium, the author has repeatedly satisfied himself of the existence of the important error (see Souchay, *Zeitschrift Anal. Chem.*, 1865, iv., 66) arising on the precipitation of chromic oxide by ammonia in glass vessels, as during the operation—by the action of the alkaline liquid, and the subsequent washing with hot water—constituents of the glass pass into the precipitate.

Souchay shows in his memoir, by comparative analyses, that this error is avoided if the precipitation of the chromium is effected not in an alkaline solution, *e.g.*, by means of mercurous nitrate, and that the result is strictly accurate if all the operations are conducted in platinum vessels, thus proving that the glass is the source of the foreign matter which occasions the difference.

The author finds that the error is greater than was determined by Souchay in his two analyses of potassium bichromate. He has also been unable to confirm the statement that on re-dissolving the washed precipitate in hydrochloric acid, and re-precipitating with ammonia, the error was doubled. The excess of chromic oxide found over the calculated quantity was in some experiments 4 per cent.—*Berichte der Deutsch. Chem. Gesell.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 6, 1880.

Prof. H. E. ROSCOE, President, in the Chair.

After the minutes of the previous meeting had been read and confirmed, the following certificates were read for the first time:—H. Brown, G. H. Hughes, H. Aubrey Lawrance, R. S. Marsden, E. A. Reilly, Brenton Symons, H. Kneebone Tompkins, A. Wingham.

The President then called on Dr. Hodgkinson to read a paper "*On the Action of Sodium on Phenylic Acetate*," by W. H. Perkin, jun., and W. Hodgkinson. One of the authors has already published some results as to the action of sodium on ethereal salts containing mixed fatty aromatic groups. In the present paper they first give an account of the action of sodium on phenylic acetate, prepared by heating dry phenol with acetylic chloride: the acetate boiled at 193° C. A most violent action took place with considerable rise of temperature. Hydrogen and much acetic ether were evolved, the silver salt from the latter being analysed. After the sodium had disappeared a solid body remained in the flask, which, when treated with water, formed a dark coloured solution and a small quantity of a thick oil. The aqueous solution yielded acetic acid, phenol, and salicylic acid. The thick oil gave on distillation some undecomposed phenylic acetate and a crystalline mass, which was pressed between filter-paper and crystallised from petroleum. Two forms of crystals were observed, and were separated by crystallisation from alcohol. The substance most soluble in alcohol forms glistening white needles melting at 48°, giving a red colouration with potash, and having the composition $C_{15}H_{12}O_3$. The other substance crystallises in yellow needles, melting at 138°, giving a yellow crystalline compound with alcoholic potash, and having the composition $C_{18}H_{14}O_4$. Experiments were now made by heating cresylic acetate with sodium. Acetic ether and salicylic acid were obtained as in the previous reaction; probably, therefore, these two substances are constant products of the action of sodium on acetyl phenols.

Dr. Hodgkinson then read a paper entitled "*Preliminary Notice on the Action of Sodium on some Ethereal Salts of Phenyl-acetic Acid.*" In a contribution to *Liebig's Annalen* by Max Conrad and the author of the present paper it has been shown that the influence of the presence of a phenyl group in ethers of fatty acids results in the substitution of one or more of the hydrogen atoms in combination with the carbon immediately joined to the carbonyl group by the group containing the phenyl, giving a synthesis of so-called aromatic fatty acids. From phenylic acetate the benzylic ether of β-phenyl-propionic acid was obtained as a primary product, and, secondarily, by the action of sodium on this substance, dibenzyl-acetic and β-phenyl-acrylic acids. Benzylic propionate, butyrate, &c., gave analogous results. The author of the present paper has experimented as to the effect of a phenyl group in the acid or negative portion of the ethereal salt. For this purpose α-toluic acid seemed likely to give results, as from its ethyl ether might be formed ethylic-phenyl aceto-acetate,—

$$\begin{matrix} C_6H_5\,CH_2 \\ CO \\ CH_2 \\ COO\,C_2H_5. \end{matrix}$$

2·5 grms. of sodium were warmed with 50 grms. of the ether. A condenser was fitted to the retort, so that the liquid produced was removed, as fast as it was formed, from contact with the sodium. In one experiment 10 grms. of a liquid distilled over, which, after re-distillation, boiled between 75° and 78°. On analysis it proved to be ethylic acetate. The residue in the retort forming a thick mass

was treated with water, and gave a solution in which sulphuric acid caused the formation of a white precipitate and an oily body; the latter was separated and distilled. On shaking the acidified aqueous solution with ether, phenyl-acetic acid was obtained, crystallising from water in long needles, melting at 76°; a small quantity of acetic acid was also obtained. The oily product on distillation separated into some unaltered ethylic phenacetate and an oil which, after purification, boiled at 250° at 60 m.m., having the composition $C_{18}H_{20}O_2$. A residual oil gave on analysis numbers indicating $C_{18}H_{16}O$. The decomposition may thus be represented—

$$6(C_6H_5CH_2COOC_2H_5)+Na_2=2(C_6H_5CH_2COONa)+2CH_3COOC_2H_5+H_2+2(C_{18}H_{20}O_2).$$

The action of sodium on other ethers of similar constitution seems to be quite analogous, but more secondary products are formed. Experiments were carried out with propylic phenyl acetate: propylic acetate was formed. From the residue in the retort were obtained phenyl-acetic acid, a substance crystallising from petroleum in white needles, having a composition indicated by the formula $C_{24}H_{20}O_3$, insoluble in acids and alkalies, and a yellow oil boiling at 335° at a pressure of 50 m.m., giving on analysis $C_{22}H_{20}O_2$. The reaction has also been extended to a primary isobutylic phenyl acetate. It appears, therefore, that the first products of the action of sodium on the ethers of phenyl-acetic acid, containing ethyl and its homologues, are the corresponding ethylic, &c., ethers of acetic acid. The phenyl group of the phenyl-acetic acid being replaced by hydrogen, it further reacts with sodium on another portion of the original ethereal salt, forming the above liquid and solid bodies whose constitution is as yet undetermined, hydrogen being at the same time evolved. With benzylic phenyl-acetate the action of sodium appears to be analogous with that on the benzylic ethers of the normal fatty acids.

After a few remarks from Dr. Frankland as to the importance of the results,

The President proposed a vote of thanks to the authors, and expressed his gratification that a son of the Secretary had already commenced to contribute papers to the Society.

The next paper was "*On the Determination of Nitrogen in Carbon Compounds*," by C. E. Groves. The author described and exhibited an apparatus for facilitating the collection and measurement of nitrogen evolved during the combustion of a substance according to Dumas's method. It consists of two vertical glass tubes, in size and shape somewhat resembling burettes. One, *a*, is graduated, and is closed at its upper end by a glass stopcock. Into its lower end is fixed a T-tube, one leg of which is attached to the combustion-tube, a bulb U-tube containing a globule of mercury being interposed. To the other leg of the T-tube is attached a long india-rubber tube, the other end of which is connected with the bottom of the second vertical glass tube, *e*. The combustion-tube is charged in the ordinary way. The tube *a* is filled with potash solution (sp. gr. 1·25), and *e* is lowered until the opening of the T-tube which leads to the combustion-tube is free: carbonic acid is then evolved, and the air in the combustion-tube swept out as usual. The graduated tube *a* is then filled with potash, and the stopcock closed as soon as the bubbles of gas are completely absorbed. The tube *e* is then lowered until the level of the potash in it is a little below the T-tube. The combustion is conducted in the ordinary manner. The advantages claimed for the apparatus are its simplicity and the fact that as the combustion is carried out under diminished pressure there is no tendency for the tube to blow out. The author also gives details of a method for using the same tube for six to twelve combustions. The mixture of CO and CO_2 obtained by the action of strong sulphuric acid on oxalic acid is recommended as preferable to hydrogen for reducing the oxidised copper gauze. The author also exhibited a simple arrangement for collecting or delivering small quantities of gas.

Mr. Perkin remarked that he had never yet been able to get all the air out of a tube by CO_2; he always had to use the Sprengel pump.

Mr. Kingzett had experienced the same difficulty as the previous speaker, and had obviated it in the same way.

Dr. Frankland strongly recommended the use of the Sprengel pump, and suggested the application of a water-jacket round the measuring-tube.

Mr. Groves, in reply, said that he had used a water-jacket round the tube, and that by passing the CO_2 for the same time at the same beginning as at the end of the combustion the error due to the minute bubble of air could be almost completely corrected.

Mr. M. M. P. Muir then read a paper "*On Essential Oil of Sage*." The results of the author may be summarised as follows:—The composition of essential oil of sage varies with the age of the oil. When freshly distilled it contains comparatively small quantities of salviol, camphor, and cedrene. As the oil ages the quantities of these substances, especially of the first two, increase. The oil distilled from English sage contains much cedrene, boiling at 260°, with small quantities of $C_{10}H_{16}$, hydrocarbons, and traces of oxidised compounds. The terpene of sage oil is identical with that from French turpentine; probably an isomeride of terpene, boiling at 171°, is also present. Salviol has the formula $C_{10}H_{18}O$, not $C_{10}H_{16}O$. When oxidised with chromic or dilute nitric acid it yields camphor, melting at 174°, with oxalic and acetic acids. Salviol on distillation is slightly decomposed, water and a $C_{10}H_{16}$ compound being produced. Sunlight, in the presence of air, and in the course of time, forms from the $C_{10}H_{16}$ compounds of sage oil, salviol, and small quantities of camphor. The latter substance is also formed by the action of sunlight on salviol. The action of phosphoric anhydride on salviol is very complex, there being formed polymerides of $C_{10}H_{16}$, one boiling at 171°, a hydrocarbon of the benzene series boiling below 130°, and a paraffin boiling between 170° and 180°: no cymene is found if the action be continued for some time. Phosphorus pentachloride acts upon salviol at high temperatures, producing a chlorinated derivative, which is decomposed on distillation, forming a $C_{10}H_{16}$ hydrocarbon boiling at 157°, and probably the paraffin-like body mentioned above. Bromine acts energetically on salviol, hydrogen and carbon being liberated. A brominated oil may be separated, and under certain conditions small quantities of camphor melting at 174°. Camphor separates chiefly from the portions of sage oil distilling between 205° and 208°; it is partially soluble in salviol, but separates out on cooling the solution to − 15°. Sage camphor melts at 174°, boils at 205°; chemically it appears to be identical with laurel camphor; it is, however, optically inactive. The compounds present in sage oil are stable when pure, but when mixed with small quantities of other bodies they decompose. Processes of oxidation, deoxidation, and polymerisation probably occur simultaneously during the ageing and fractionation of sage oil. In discussing his results the author expresses an opinion that the camphor group may be regarded as a link between the "closed chain" and the $C_{10}H_{16}$ series, just as the $C_{10}H_{16}$ group forms a link between the fatty and the closed chain compounds.

Dr. Wright complimented the author on the completeness of his paper. Though some of the reactions had been already worked out, additional and more complete evidence was always very valuable. He thought the author's views as to the relation between the closed chain compounds and the camphors were open to discussion.

Mr. Kingzett had been much interested in the paper, as it seemed that in many points the oxidation of sage oil was analogous to that of the terpenes. In one experiment he had obtained from turpentine colourless crystals closely resembling camphor. He should like to ask if Mr. Muir had observed during the oxidation of sage oil in the air any production of hydroxyl.

Mr. MUIR had not specially looked for hydroxyl during the present investigation, but had noticed its formation in a previous research. He also replied to the criticisms of Dr. Wright on the theoretical portion of the paper.

Mr. A. H. ALLEN then read a paper "*On the Presence of Nitrogen in Iron or Steel*," which will appear in our next issue.

The following papers were taken as read:—

"*On the Mode of Application of Pettenkofer's Process for the Determination of Carbonic Acid in the Expired Air*," by W. MARCET. The author describes the apparatus which he has used in upwards of 350 determinations during a series of experiments on the influence of altitude on the phenomena of respiration (*Proc. Roy. Soc.*, 1878 and 1879). The air from the lungs is collected into a large india-rubber bag, whose capacity under a certain pressure was known; two bags were used, one holding 39·3, the other 68·4 litres. For the analysis of the air the following apparatus is used:—A thick glass tube or cylinder, about 2 litres capacity, is supported on a light tripod stand; both ends are ground and are closed with thick ground glass discs, which by means of grease and two screwed brass caps close the cylinder air-tight. In the upper glass disc three holes are made, in which fit air-tight a thermometer and two brass stopcocks. The lower disc has attached to its inner surface a thick vulcanite disc, whose upper part is slightly funnel-shaped, so as to drain off completely any liquid from the cylinder. Perforations are made in the lower disc for attaching a tube from an air pump, and for drawing off liquid. The cylinder is first dried and exhausted and the air from the large bag allowed to enter; the cylinder is again exhausted and filled a second time, the pressure being noted by a manometer and the temperature observed. A measured quantity of standard baryta solution is now introduced, the increase of volume is diverted into a small empty india-rubber bag connected with the cylinder, so that the pipette can be emptied by closing its top and warming the bulb with the hand. All the stopcocks are now closed and the cylinder gently shaken; the milky liquid is then run into a bottle, which is corked and paraffined. Some of the clear liquid is decanted into a burette and titrated against a measured quantity of standard oxalic acid, turmeric being used as an indicator. The whole apparatus is portable, and the results are perfectly reliable. The details of an experiment with the calculations are given.

"*Note on an Improved Form of Oven for Heating Sealed Tubes and avoiding Risks of Explosions*," by WATSON SMITH. The author has constructed such an oven having the following advantages:—A temperature of 420°—440° can be obtained in a few minutes with one moderately large Bunsen. It ensures the safety (in case of explosion) of the experimenter and of the thermometer. It has a simple construction, and can be cooled down rapidly. It consists of a horseshoe-shaped inner tube of stout sheet iron, which contains thick iron tubes, surrounded by an outer D-shaped cover of sheet iron. A figure accompanies the paper.

"*Note on a Convenient Form of Lead Bath for Victor Meyer's Apparatus for Determining the Vapour Densities of High Boiling Substances, together with a few slight modifications*," by WATSON SMITH. The author advises the cutting off the capillary delivery tube about half an inch from the main stem, and connecting the cut off delivery tube to the main stem with a piece of caoutchouc tubing only when everything is adjusted for a determination. Detailed drawings with measurements accompany the paper. A piece of iron gas-tube, 9 to 10 inches long and 2 inches internal diameter, forms the lead bath; two screens of sheet iron are used, one to steady the gas flame, the other to protect the upper part of the apparatus from draughts. The glass bulb is well smoked in a luminous gas flame, and introduced into the lead very gradually.

After the thanks of the meeting had been given to the authors for their respective papers, the Society adjourned to May 20th, when a paper will be read "On the Oxidation of Peaty Matter," by Miss Lucy Holcrow and Dr. E. Frankland, and the discussion on Dr. Tidy's paper (which will be printed this week) "On River Water," will take place.

PHYSICAL SOCIETY.

Ordinary Meeting, May 8, 1880.

SIR WILLIAM THOMSON, President, in the Chair.

NEW members: E. F. Bamber, Dr. E. Obach, R. D. Turner, E. Woods, H. E. Roscoe, H. Watts.

Prof. MINCHIN, of Cooper's Hill Engineering College, described his further researches in the subject of photo-electricity brought by him before the last meeting of the Society. He has found that the current in a sensitive silver cell does not always flow from the uncoated to the coated plate. It does when chloride or bromide of silver is used, but when the sensitive emulsion is iodide of silver and the liquid water tinctured with iodide of potassium, the current is from the coated to the uncoated plate. He demonstrated that the current set up by the fall of light on the cell could be sent by wire to a receiving cell and made to produce a local effect on the sensitive plate therein. He also proved that electricity is developed in fluorescent bodies by the action of light, and hopes to show that it is also developed in phosphorescent bodies. Neither heat nor the red rays produce this electricity, but it is the blue and violet rays which do so. The fluorescent silver plates he employed were coated with an emulsion of eocine and gelatine, and had kept sensitive for twelve days. They would thus be a permanent source of photo-electricity did the eocine not tend to leave the gelatine. Mr. Wilson had suggested naphthaline red for eocine, as not apt to leave the gelatine, and he had found it give good results.

Dr. O. J. LODGE described certain improvements which he had made in his electrometer key designed for delicate electrical and especially electrostatic experiments. Assisted by the British Association he had made it more convenient, and fitted it into an air-tight case which could be artificially dried. The contact pins were now of phosphor-bronze, gilt, instead of platinum, and the contacts were made by press-pins from the outside. Dr. Lodge also exhibited a new inductometer or modified form of Prof. Hughes's induction balance, combining a Wheatstone balance, and expressly designed for comparing capacities and resistances, especially the resistances of coils having no self-induction. A telephone takes the place of a galvanometer in the bridge, and the current in the primary coil is interrupted by a clockwork make and brake. There is one primary coil of fine wire, 3½ ohms in resistance, and two secondaries, one on each side of it, of fine wire, each about 270 ohms; these are fixed, but the primary is adjustable by a screw.

Prof. HUGHES remarked that he had pointed out in his paper to the Royal Society that the induction balance could be used in this way; and Dr. Lodge disclaimed any novelty in the apparatus beyond its arrangement.

Sir W. THOMSON added that it was satisfactory to see so serviceable an adaptation of the induction balance to research.

Dr. HOPKINSON, Prof. PERRY, and SIR W. THOMSON offered remarks on the element of time in comparing discharges from condensers of different dielectrics. Sir W. Thomson said that in 1864 he had made experiments on air and glass dielectrics and found the discharge about the same for the first quarter second.

Prof. ADAMS then took the Chair, and

Sir W. THOMSON made a communication on the elimination of air from a water steam pressure thermometer, and on the construction of a water steam pressure thermometer. He said it was a mistake to suppose that air was expelled by boiling water, because the water dissolved

less air when warm than when cold. The fact was due to the relations between the density of air in water and the density of air in water vapour. There was fifty times more air in the water vapour over water in a sealed tube than in the water below. If this air could be suddenly expelled only 1-50th part of air would remain, and of this only 1-2500th in the water, the rest being in the vapour. This suggested a means of eliminating air from water, which he had employed with success. It consisted in boiling the water in a tube, and, by means of a fluid mercury valve, allowing a puff of the vapour to escape at intervals. Sir W. Thomson also described his new water steam thermometer, now being made by Mr. Casella. It is based on the relations of temperature and pressure in water steam, as furnished by Regnault's or other tables, and will consist of a glass tube with two terminal bulbs, like a cryophorous, part containing water, part water steam, and the stem enclosed in a jacket of ice-cold water. Similar vapour thermometers will be formed, in which sulphurous acid and mercury will be used in place of water, or in conjunction with it. For low or ordinary temperatures they will be more accurate than ordinary thermometers.

SOCIETY OF ARTS.

Section of Applied Chemistry and Physics.

Thursday, April 8th, 1880.

Prof. Charles Graham, D.Sc., F.C.S., in the Chair.

The paper read was on "*The Newer Artificial Colouring Matters Derived from Benzene*," by R. J. Friswell, F.C.S., F.I.C.

Methylaniline Violets.—It is, no doubt, well known to many here that the earliest violets obtained by artificial means were those produced by the action of pure aniline or phenylamine on roseine, in the presence of an organic acid. A study of this reaction by Hofmann led to his discovery of the action of the iodides of the alcoholic radicles, methyl and ethyl, on roseine base, with the production of the well-known "Hofmann violets." These were found to be substitution-products of rosaniline, in which one, two, or three atoms of hydrogen in the molecule are replaced by the radicles methyl or ethyl, according as the iodide of either has been used.

Now roseine itself is, as is well known, produced by the action of arsenic acid or other oxidising agents on a mixture of aniline and toluydine. The chemical formula then adopted for it led to the conclusion that it was produced by the coalescence of the residues of two molecules of toluydine and one of aniline, thus :—

$$C_6H_5NH_2+2C_6H_4CH_3NH_2-H_6=C_{20}H_{19}N_3.$$

O. and E. Fischer have recently shown that this formula was partly erroneous, and that the reaction could also occur between two molecules of aniline and one of paratoluydine—

$$2(C_6H_5NH_2)+C_6H_4CH_3NH_2-H_6=C_{19}H_{17}N_3\,;$$

but this does not affect the inference drawn from what was, till recently, supposed to be the constitutional formula of the body in question, and this inference was that the methylated derivatives of roseine could be obtained by the oxidation of the methylated derivatives of aniline, just as roseine was by the oxidation of aniline and toluydine. The inference was somewhat rash; the methyl groups in dimethylaniline replace the hydrogens in the amido group, and on oxidation might, perhaps, be destroyed. However, on oxidation, dimethylaniline did, indeed, produce a very brilliant violet colour, which, having been discovered by M. Lauth, and improved and patented by Messrs. Poirrier and Chappat, was introduced into commerce under the name of Paris violet. This achievement led to a demand for the production of the methylanilines on a large scale, and, in a very short time, this was attained. It was well known that methylaniline could be produced by the action of methyl iodide, or bromide, upon aniline, the dimethyl compound resulting from the use of two molecules of the alcoholic compound; thus—

$$C_6H_5NH_2+2(CH_3I)=C_6H_5N(CH_3)_2+2HI\,;$$

but it was evidently necessary to produce the required compound in a cheaper way. This was eventually done by heating aniline hydrochloride and methylic alcohol together, under pressure, in strong cast-iron vessels, enamelled inside, and known as "autoclaves." Various proportions of the bodies have been employed—among others, the following giving good results :—Aniline, 33·6; hydrochloric acid, 37·9; methylic alcohol pure, 28·5; heat to 250° C. for eight hours. Messrs. Poirrier have also employed a mixture of 100 parts aniline and 250 methyl nitrate. In the latter case, the mixture requires only a temperature of 100° C.; but the alcoholic nitrate is an exceedingly dangerous compound to deal with; in all probability, it was the one that led to the lamented death of Mr. E. T. Chapman, and a very disastrous and fatal explosion at Messrs. Poirrier's works was also caused by it.

Methylaniline is now largely made by the action of methyl chloride on aniline. As is well known, the former body has, of late years, been obtained in immense quantities in France, from a product of the destructive distillation of residues obtained in the manufacture of beet sugar. This body reacts upon aniline just as the corresponding iodide or bromide does; it is cheap, the reaction takes place with ease, and a remarkably pure product is produced; in fact, dimethylaniline can now be obtained by the ton, free from unaltered aniline, and containing only 3 per cent of the mono-methylated compound.

From dimethylaniline the violet is obtained by oxidation; formerly, various oxidising agents were used, among them a mixture of iodine and potassium chlorate. It is, however, now well known that very gentle oxidisers will produce the colour if a metallic salt is present, the one preferred being copper. If I heat in this tube some copper filings with a mixture of dimethylaniline and chloral hydrate, the whole will shortly become a mass of semi-solid violet. It is, however, obvious that so costly a method could not be employed on a manufacturing scale, and accordingly the following process is in very general use :—20 parts pure crystallised cupric nitrate are dissolved in 20 parts of acetic acid; some common salt is now stirred in to the mixture, which is carefully cooled down to the ordinary temperature, and 50 parts of dimethylaniline are added; the whole is then thoroughly mixed with about 250 to 300 parts of white sand, and the stiff mass thus produced is moulded into large cakes, 2 feet long by 15 inches wide, and 4 inches thick; these arranged on copper plates, are placed in a chamber, and heated to a temperature of 60° C. for forty-eight hours. At the end of that time, they have become perfectly hard and brittle, and of a bright brassy colour. They are broken into a coarse powder and thrown into water, sulphide of sodium being added until the whole of the copper-salt has been decomposed. The mass is now washed with water and extracted with dilute hydrochloric acid at a boiling temperature. After partial cooling and filtration, to remove some resinous by-products, the colouring-matter is precipitated with common salt, and, after drying, it is ready for use. The sand, which simply serves to spread the mixture over a large surface, can be used for a fresh operation.

The product thus obtained is very brilliant in colour, and in shade is that known as 3 B, dahlia, &c.; it is, however, not the bluest that can be produced. The bluest shades are made by dissolving it in alcohol, converting it into base by the cautious addition of caustic soda, and then heating the alcoholic solution of the base with benzyl chloride—a body having the formula $C_6H_5CH_2Cl$, and produced by the action of chlorine on toluene. The spirit and unaltered benzyl chloride are

recovered, and the basic colour, on conversion into the hydrochloride, is ready for use. In a similar way, by the action of methyl chloride, the well-known methyl green was produced; it is now, however, replaced by the malachite green, discovered by Oscar Doebner, and produced by the action of one molecule of benzoyl trichloride, $C_6H_5CCl_3$, on two molecules of dimethylaniline or of benzoyl-hydride, or bitter almond oil, C_6H_5COH, on the same in the presence of zinc chloride or of sulphuric acid.

The latter colour much surpasses the former in fastness and power of standing rough treatment in the dyeing process. The methyl, and, still more, the iodine green obtained during the manufacture of blue shades of Hofmann violet, were fugitive and easily altered by heat, so that the latter could not be boiled without changing to a violet.

Before leaving the methylaniline colours I may briefly allude to a question of scientific interest in connection with them. It is well known that Hofmann himself, at one time, considered the violets obtained by the methylation of rosaniline and those from methylaniline to be identical. On the other hand, there was much evidence against this view, for the methylaniline colour was readily rendered bluer in shade by benzyl chloride, which was almost without action on the Hofmann one; it was also more brilliant, had a much greater affinity for animal fabrics, and was less permanent when exposed to light. For these reasons the Hofmann colour is still in demand, and, indeed, has recovered some of the ground it at first lost to the more brilliant colour. The researches of Brunner and Brandenburg, following those of Caro and Graebe, have shown that the methylaniline violets are not identical with those obtained by Hofmann's process.

Diphenylamine Blue and Alkali Green.—The ordinary aniline blues are obtained by the action of aniline upon roseine base, in the presence of an organic acid, at a temperature which ultimately approaches the boiling-point of the aniline used. The ultimate product of this reaction is an exceedingly intense blue, the hydrochloride of which is known as opal blue, and is really the hydrochloride of triphenyl-rosaniline. This, on dry distillation, yields diphenylamine, and the latter body, on oxidation, yields a blue which is identical with that obtained from rosaniline, but somewhat greener in shade, and is therefore in demand for certain uses. The diphenylamine is prepared by heating, under pressure, a mixture of aniline and dry aniline hydrochloride, when the following reaction occurs:—

$$C_6H_5NH_2 + C_6H_5NH_2HCl = (C_6H_5)_2NH + NH_4Cl.$$

Diphenylamine is readily oxidised if heated with oxalic acid, and the resulting melt, purified from unaltered oxalic acid, diphenylamine and resinous matters, is readily converted into either of the sulphonic compounds discovered by Nicholson. Blues of a redder shade can be also obtained by the oxidation of methyl- or ethyl-diphenylamine.

I have now to call your attention to a green obtained from this body, discovered by Mr. R. Meldola, and now under his investigation. It is obtained by the oxidation of a diphenylamine derivative. After oxidation the colour is obtained in a state corresponding to the well-known opal-blue, and, like that, forms sulphonic acids. It is remarkable as being the first green obtained having this property. The sodium salt of the sulphonic acid is soluble in water, and, if wool is immersed in this solution (which is nearly colourless), and kept warm, it apparently undergoes but slight change. I have here a piece of Berlin wool which has been thus treated, and subsequently dried. You will observe that it is apparently only rather dirtier than undyed wool. When, however, I immerse it in warm water, acidulated with sulphuric acid, a brilliant green is immediately developed. The colour is remarkably fast; and since it requires exactly the same dyeing process as do the Nicholson blues for wool, one would have supposed that it would have been much liked by the dyers; but this is not at present the case. It was exhibited at the late Paris Exhibition by the firm of Brooke, Simpson, and Spiller.

As time is getting on, I must now leave this very interesting field—the colours produced by the oxidation of the secondary and tertiary amines—after a very brief and incomplete glance at a few of them, and pass on to the consideration of a totally distinct group of colouring-matters, which are now attracting much attention in colour-chemists' laboratories, and which have already taken an important place among artificial dyes, though, as yet, the range of shades is somewhat limited. These are obtained from substances produced by the action of nitrites on amido compounds, and are known as the azo yellows, oranges, and scarlets.

The effect of nitrites on organic compounds is very various, according to the subsequent treatment they undergo; thus, if nitrous gas is passed through a solution of diphenylamine in acetic acid, a mixture of nitroso-nitro-diphenylamines results, and this, on heating with an alkali, decomposes so far as the nitroso groups are concerned, and a mixture of mono- and dinitro-diphenylamine results, which was introduced as a yellow dye by Mr. R. Meldola. A somewhat similar reaction occurs if the sulphonic acid of alpha-naphthol is similarly treated, and dinitro-naphthol may be obtained; while, if a nitrite is added to an aniline salt, and the resulting compound boiled, or if rosaniline salts are similarly treated, the whole of the nitrogen is eliminated with effervescence, and phenol in the one case, rosalic acid in the other—both of them non-nitrogenous substances—result. Before this boiling takes place, there are, however, in the two latter cases, very different bodies in solution; these bodies, which behave in the manner just mentioned on boiling, are known to chemists as "azo compounds."

In the earlier days of organic chemistry, the prefix "azo" was applied by Mitscherlich, Laurent, Zinin, and others to many bodies containing nitrogen, such as azo-benzene, $C_6H_5N=NC_6H_5$, produced by the imperfect reduction of nitro-benzene, and also to others, like the compounds obtained by Laurent by the action of ammonia on bitter almond oil and other bodies. In 1864, however, P. Griess published a magnificent memoir, in which he described a number of bodies obtained by the action of nitrous acid on aniline, and various substitution-products obtained therefrom. In this paper, he proposed that the prefix "azo" should be held to mean that the compound to which it was applied contained one atom of nitrogen occupying the place of one atom of hydrogen. This definition is now generally accepted, and thus the term "azo" has obtained a definite signification.

The azo compounds are, as a rule, very easily prepared; in most cases, it is only necessary to add a solution of metallic nitrite to an acid solution of a given amide, in order to obtain the diazo compound of the radicle contained in the amide; thus, if I take a solution of aniline hydrochloride, and add to it an equivalent quantity of sodium nitrite solution, the reaction at once takes place, and diazo-benzene is produced; it can be readily separated from its solution, and obtained in the solid state, one method being to add a solution of potassium dichromate, when the chlorochromate of diazo-benzene is produced. This salt when dry is terribly explosive, and at one time was suggested for use in warlike operations; however, it very rapidly decomposes when kept, losing nitrogen, and becoming no longer efficient.

This explosiveness is readily understood when we consider the constitution of the body which contains the group $-N=N-$. It is manifestly in a state of unstable equilibrium, and a very slight disturbance is sufficient to bring about its decomposition; and, for the same reason, you will at once see that its chemical activity, as measured by its tendency to combine with other bodies, will be great; so that, if I add to it another molecule of aniline salt, or, what amounts to the same thing, if I add to two molecules of aniline only one of sodium nitrite, the diazo-benzene formed at once attacks the free aniline salt, and what is

known as diazo-amido-benzene is formed, which, in the presence of an aniline salt, becomes amido-azo-benzene, $C_6H_5N=NC_6H_4NH_2$. The oxalate of this body was once in pretty general use as a yellow dye, but, as it happened to be volatile at a very low temperature, it soon evaporated from the dyed article, and was, therefore, discarded.

A compound having a very similar constitution and mode of preparation has, however, long been in use, and is one of the most permanent of the aniline colours, under the name of "Bismarck brown." It is obtained as follows:—

Meta-dinitro-benzene is prepared by boiling ordinary nitro-benzene with nitric acid. The compound thus produced is added cautiously, with constant agitation, to coarse iron borings, kept boiling in a large quantity of water acidulated with hydrochloric acid. A violent reaction soon commences (I could readily show you the experiment, but for the steam and unpleasant odour produced); the four oxygen atoms contained in the dinitro-benzene are replaced by hydrogen, thus:—

$$4C_6H_4(NO_2)_2+Fe_{15}+4OH_2=4C_6H_4(NH_2)_2+5(Fe_3O_4).$$

We have thus produced diamido-benzene, and this, when purified from a little dissolved iron, is attacked with sodium nitrite solution; the reaction here is analogous to the one last described, the final product of the reaction being a triamido-azo-benzene, the hydrochloride of which constitutes the well-known colouring-matter. We have thus two terms of a possible series—first, the amido-azo-benzene (yellow, volatile, and fugitive), and triamido-azo-benzene (brown, and perfectly fast). Dr. Witt set himself the task of filling up the intermediate link, expecting an orange colour, and a moderate stability for the diamido-azo-benzene he sought. In this he was not disappointed. A study of the two compounds from a purely scientific point of view, led him to a perfectly accurate prediction; and the discovery of "chrysoidine," as the new colour was called, and its production—by the addition of diazo-benzene chloride to a solution of diamido-benzene—was one of the first of a series of researches which have in various hands enriched our science and our dyers with a number of magnificent colours.

The further development of these colours commenced with the introduction of a sulphonic group into one of the amido compounds, the conversion of the sulphonic acid thus produced into a diazo body, and then using it as before; for instance, if sulphanilic acid—produced by the action of strong sulphuric acid on aniline—is converted into diazo-sulphanilic acid, and this added to a solution of diamido-benzene hydrochloride, the scarlet body produced is the sulphonic acid of chrysoidine. Again, the same body will act on resorcine to produce a colour only differing from the last in that it contains hydroxyl instead of amido groups; this body has been used as a dye, under the name of Tropæoline 0. Witt also produced, by substituting diphenylamine for the resorcine, or diamido-benzene, another beautiful orange, known in commerce as Tropæoline 00 Other compounds were subsequently prepared, and have obtained greater prominence; these were those in which a naphthol was substituted for the phenolic or amido portion of the molecule, beautiful oranges being produced by the action of diazo-benzene sulphonic acid on both α- and β-naphthol; but these colours were much improved by the introduction of sulphonic groups into both portions of the molecule, α- or β-naphthol-sulphonic acid being, in fact, substituted for the naphthol only; still, so far, the improvement was in the direction of stability mainly, the shades still being yellow or orange; the red was yet to come.

Chemists will not be surprised to hear that the higher homologues of benzene are found, when converted into amido compounds, to give an increased redness of shade; thus, with a given phenol or amine, diazo-sulpho-toluydinic acid, which differs from diazo-sulphanilic acid by having an atom of hydrogen in the benzene ring replaced by methyl, gives redder shades than does the latter, while the substitution of another hydrogen in the same way, as is the case with the diazo compound derived from sulphoxylidenic acid, produced a scarlet. Messrs. Meister, Lucius, and Bruning were among the first to produce a scarlet by this method, but they also introduced both the sulpho groups into one side of the molecule—that of the naphthol. In their patent they describe the preparation of two isomeric β-naphthol-disulphonic acids, the sodium salts of which are differently soluble in alcohol, the most insoluble one giving a redder colour than the other. On one or other of these they act with diazoxylene chloride, produced by the action of a nitrite on xylidine chloride. The most insoluble salt above mentioned gives a scarlet closely approaching cochineal, and perfectly fast.

Mr. R. Meldola has also taken out a patent for a scarlet, in which no less than three sulpho groups are engaged. He prepares diazo-sulphoxylidenic acid, and with this acts on β-naphthol disulphonic acid; on the addition of ammonia, the colour is immediately thrown down, as you perceive. This is, after a slight purification, ready for use. By certain modifications, a scarlet, closely approaching the scarlet obtained by dyeing cochineal in the presence of oxychloride of tin, is produced.

So far, we have only oranges and scarlets by these reactions. Whether other colours can be similarly produced remains to be seen; but I may mention that Mr. Meldola has recently communicated a paper to the Berlin Chemical Society, in which he describes a violet colour—unfortunately not a dye—obtained in a somewhat similar way. If we act on dimethylaniline—the body from which the violets described in the first part of my lecture are derived—with a nitrite, not an azo-, but a nitroso-dimethyl-aniline, is produced thus:—$C_6H_4NON(CH_3)_2$. This body is as ready to combine with others as an azo body is, and does so in a very similar way, the oxygen atom being eliminated in the process, so that if we act with it on β-naphthol the following combination takes place*:—

$$C_6H_4.N.N(CH_3)_2$$
$$\|$$
$$\beta C_{10}H_5HO$$

The oxygen of the nitroso group going off with two hydrogens from the β-naphthol, the place of which is taken by a group, which is equivalent to azo-dimethylaniline. The colour crystallises magnificently, but its dyeing powers are very feeble.

I must now conclude a very imperfect sketch of some of the recent advances of colour chemistry. If I have succeeded in showing some that practical results do come from purely scientific researches, I am content. Hard things are often said of the aniline dyes; they are looked on as poisonous and fleeting. The first accusation is untrue, properly used they are perfectly harmless. The second is only true of some few of the series, and many of the older dyes are equally evanescent, while none are so beautiful and brilliant—though this may be considered a fault, for some highly æsthetic persons look on the producer of brilliant colours almost as a criminal.

The colour chemist may contemplate all these hard sayings with an even mind. In the humble position of a scavenger, he takes some of the most noxious waste-products of our civilisation—those produced in the gas manufacture—and converts them into useful and beautiful colouring-matters. If these are improperly applied to the cloth or fabric that is not his fault; while if they are inartistically used our æsthetic friends have the remedy in their own hands.—*Journal of the Society of Arts.*

Theory of Inconstant Galvanic Elements.—F. Exner.—The author shows the non-existence of a so-called galvanic polarisation in the elements, the phenomena in question being reducible to the action of the oxygen dissolved in the water.—*Wiener Anzeiger*, 1879, 292.

* This formula is given under reserve, as a complete investigation of the compound has not yet been published.

CORRESPONDENCE.

DEPHOSPHORISATION OF IRON.

To the Editor of the Chemical News.

Sir,—For many years it has been considered that crude iron should contain about 2 per cent of silicon in order to be suitable for the Bessemer process. In a letter which appeared in the *Times* of the 10th June, 1879, I endeavoured to point out that comparatively non-silicious iron could be more readily dephosphorised than iron containing a larger percentage of silicon, and I am pleased to find, from the papers read and the discussions that took place at the last meeting of the Iron and Steel Institute, that this is now an admitted fact. It is, however, phosphorus, not silicon, that is now thought to be a necessity in order to produce the requisite heat for the operation, and I venture to submit the following figures in order to demonstrate that this also is erroneous, and that there is no gain in available heat by increasing the percentage of phosphorus in the crude iron to be Bessemerised. A larger proportion of phosphorus means more air required for oxidation, therefore more blast and a slower operation, besides necessitating an additional quantity of basic material, with its attendant increased yield in slag as compared to the product of steel, and more wear and tear of the basic lining.

In Mr. R. Pink's paper, read last week before the Iron and Steel Institute, on "The Dephosphorisation of Iron in the Bessemer Converter," will be found the following analyses:—

Analyses of Metal (Charge 67), composed of 2400 lbs. foundry No. 3, 3000 lbs. white forge, 1000 lbs. steel scrap.

	P	C	S	Mn	Si
As taken from cupola ..	1·04	2·58	0·22	1·35	1·08
After blowing 11·75 mins. on fall of carbon lines	0·82	0·08	0·19	0·39	0·09
At overblow of 100 secs.	0·08	0·06	0·15	0·39	0·007
Further blow of 15 secs.	0·045	0·04	0·14	0·37	0·005
After addition of 420 lbs. of spiegeleisen containing 17 per cent Mn ..	0·06	0·28	0·067	0·46	0·002

(6820 lbs. total weight of raw material; 6074 lbs. weight of steel produced.)

Analysis of Slag (Charge 67).

Silica	9·50 per cent.
Phosphoric acid	9·76 ,,
Magnetic oxide, Fe_3O_4..	9·28 ,,
Peroxide of iron	— ,,
Oxide of manganese, Mn_3O_4 ..	6·16 ,,
Lime	59·35 ,,
Magnesia	5·01 ,,
Sulphate of Lime..	0·87 ,,
Alumina	trace
	99·93 ,,

The weight of the slag is not given, but calculated from the percentage of phosphoric acid in the slag formed it is equivalent to 23 per cent of the weight of crude iron operated on.

9·76 per cent : 100 : 0·02245 : 0·23.

On these analyses I have based the following calculations, which I think bear out the opinion I have above expressed:—

Heat Units.

1·0 Crude iron × 0·1138 sp. heat of Fe (Regnault) × 1650° C. {Temperature at which it is assumed the iron is introduced into the Bessemer.} = 187·7

0·0098 P burning with 0·01265 O = 0·02245 P_2O_5 ∴ 0·0098 P × 5708 calorific value of P (mean of Andrews and Abria) .. .. = 55·9

0·0254 C ,, 0·03387 O = 0·05927 CO ∴ 0·0254 C × 2473 cal. val. of C (Favre and Silbermann) .. = 62·8

0·0008 S ,, 0·0008 O = 0·0016 SO_2 ∴ 0·0008 S × 2220 cal. val. of S (Favre and Silbermann) .. = 1·8

0·0098 Mn ,, 0·00386 O = 0·01366 Mn_3O_4 ∴ 0·0098 Mn × 1639 cal. val. of Mn (assumed to be the same as that of Fe) .. .. = 16·1

0·0103 Si ,, 0·01178 O = 0·02208 SiO_2 ∴ 0·0103 Si × 7830 cal. val. of Si (Troost and Hautefeuille) = 80·6

0·0168 Fe ,, 0·0064 O = 0·0232 Fe_3O_4 ∴ 0·0168 Fe × 1639 cal. val. of Fe (mean of Andrews and Dulong) .. .. = 27·5

0·0729 0·06936 0·14226

$\frac{0·06936\ O \times 76·3}{23·7}$ = 0·22329 N = 0·29265 air × 0·2375 sp. heat of air (Regnault) × 50° C. {Temperature at which the air is blown in} = 3·5

435·9

0·0254 C burning with 0·033870 = 0·059270 CO × 0·245 sp. heat of CO (Regnault) = 0·0145

0·0008 S ,, 0·0008 O = 0·0016 SO_2 × 0·154 sp. heat of SO_2 (Regnault) = 0·0002

0·22329 N × 0·244 sp. heat of N (Regnault) = 0·0545

Temperature at which it is assumed the gases escape, 1500° C. × 0·0692 = 103·8

Heat units .. .. 332·1

0·0098 P burning with 0·01265 O = 0·02245 P_2O_5 + 0·02481 CaO =	0·04726	$Ca_3P_2O_8$	× 0·205	sp. heat of $Ca_3P_2O_8$	= 0·0097
0·0098 Mn ,, 0·00386 O =	0·01366	Mn_3O_4	× 0·17	,, Mn_3O_4	= 0·0023
0·0103 Si ,, 0·01178 O =	0·02208	SiO_2	× 0·23	,, SiO_2	= 0·0051
0·0168 Fe ,, 0·0064 O =	0·0232	Fe_3O_4	× 0·17	,, Fe_3O_4	= 0·0039
59·35 per cent CaO × 0·23 slag = 0·1365 CaO − 0·2481 CaO =	0·1117	CaO	× 0·202	,, CaO	= 0·0226
5·01 ,, MgO × 0·23 slag =	0·0115	MgO	× 0·266	,, MgO	= 0·0031
0·87 $CaSO_4$ × 0·23 slag =	0·002	$CaSO_4$	× 0·2	,, $CaSO_4$	= 0·0004

0·2314 slag, *i.e.*, 23 p. c. slag per ton of metal.

1·0 Crude iron = 0·11 loss by oxidation, &c. = 0·89 Fe × 0·1138 sp. heat of Fe = 0·1013

0·1484

$\frac{332·1}{0·1484}$ = 2238° centigrade.

From the foregoing it will be seen that—

0·0098 P burning with 0·01265 O = 0·02245 P_2O_5
∴ 0·0098 P × 5708 calorific value of P = 55·9

$\frac{0{\cdot}01265\ O \times 76{\cdot}3}{23{\cdot}7}$ = 0·04072 N × 0·244 sp. ht. of N × × 1500° C. temperature, at which it is assumed the gases escape .. .. = 14·9

41·0

0·02245 P_2O_5 + 0·02481 CaO = 0·04726 $Ca_3P_2O_8$ × × 0·205 sp. heat of $Ca_3P_2O_8$ .. .. = 0·0097

5 per cent additional lime added for each 1 per cent of P contained in the crude iron 0·05 CaO × 0·202 sp. heat of CaO.. .. .. = 0·0101

0·0198

$\frac{41{\cdot}0}{0{\cdot}0198}$ = 2071° Centigrade.

Although as shown by the above figures the oxidation of phosphorus will not supply the additional amount of heat that may be requisite, this can easily be obtained by burning the CO to CO_2 in a converter specially constructed for that purpose.

RICKMAN AND THOMPSON'S AMMONIA PROCESS.

To the Editor of the Chemical News.

SIR,—In reply to the enquiry in the CHEMICAL NEWS, vol. xli., p. 220, I beg to say that any correspondence on this matter should be addressed as follows:—Messrs. Rickman and Thompson, care of Messrs. Pellatt and Co., Falcon Glass Works, 17, St. Bride Street, E.C.—I am, &c.,

JAS. PELLATT RICKMAN.

CARBON IN STEEL.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xli., p. 152, Mr. James W. Westmoreland, in an article on "The Estimation of Carbon in Steel," mentions as one of the objections to the direct combustion process, advocated by Mr. W. D. Herman, "the uncertainty as to the completeness of the reaction." Now, this is precisely one of the points in which the process proposed by Mr. Herman has an advantage over other methods of combustion formerly employed, as he points out in his paper describing the process (*Journal*

Heat Units.

0·0254 C burning with 0·06774 O = 0·9314 CO_2 ∴ 0·0254 C × 8080 calorific value of C + O_2 .. .. = 205·2

$\frac{0{\cdot}06774 \times 76{\cdot}3}{23{\cdot}7}$ = 0·21808 N × 0·244 sp. heat of N = 0·05322

0·09314 CO_2 × 0·216 ,, CO_2 = 0·0201

0·7332 × 1500 C., temperature at which it is assumed gases escape .. .. 110·0

95·2

0·0254 C burning with 0·03387 O = 0·05927 CO ∴ 0·254 C × 2473 calorific value of C + O = 62·8

0·05927 CO × 0·245 sp. heat of CO 0·0145

$\frac{0{\cdot}03387\ O \times 76{\cdot}3}{23{\cdot}7}$ = 0·10904 N × 0·244 sp. heat of N = 0·0266

0·0411 × 1500° C. = 61·6

1·2

Heat units 94·0

$\frac{332{\cdot}1 + 94{\cdot}0}{0{\cdot}1484}$ $\frac{426{\cdot}1}{0{\cdot}1484}$ = 2871° C.

This figure of 2871° C., however, is far too high, because it is not probable that complete combustion of the CO to CO_2 would take place, and it is certain that the escaping gases would carry away more heat than has been calculated. Without doubt, however, if the CO were burnt to CO_2 sufficient heat would be obtained to permit of white iron containing neither silicon nor phosphorus being Bessemerised.—I am, &c.,

JOHN HOLLWAY.

London, May 11, 1880.

PS.—The heat rendered latent in the melting of the slag has been ignored for want of the requisite data.

AMMONIA FROM ATMOSPHERIC NITROGEN.

To the Editor of the Chemical News.

SIR,—It may interest your correspondent "J. H." and others to know that Messrs. Rickman and Thompson's patent for the above process has been anticipated by Clarke and Smith's patent—No. 4650 for 1878; filed November 16, 1878; sealed February 7, 1879, a copy of which I beg to enclose.—I am, &c.,

E. S.

May 11, 1880.

Chem. Soc. [2], viii., 375), that the oxide of iron formed by the combustion has invariably the composition of Fe_2O_3, and agrees exactly with the amount calculated from the steel employed, after deducting the carbon found. Of course, when it is ascertained that the whole of the steel has been converted into Fe_2O_3, there can be no doubt that the combustion of the carbon is also complete, and Mr. Westmoreland's objection as to the uncertainty of the completeness of the reaction falls to the ground.—I am, &c.,

GEORGE E. DAVIS.

Royal School of Mines.—Mr. W. Chandler Roberts, F.R.S., Chemist to the Mint, has been appointed to the Lecturership of Metallurgy in the Royal School of Mines, rendered vacant by the resignation of Dr. Percy, F.R.S. Mr. Roberts will continue to hold his appointment at the Mint. Mr. Richard Smith, hitherto assistant metallurgist has been appointed instructor in assaying.

Researches on Picrotoxin.—L. Barth and M. Kretschy.—Picrotoxin is a mixture of three compounds; true picrotoxin, $C_{15}H_{16}O_6$, very bitter and highly poisonous; picrotin, $C_{25}H_{30}O_{12}$, bitter, but not poisonous; and anamartin, present only in small proportion, and neither bitter nor poisonous.—*Wein. Anzeiger*, 1880, 2.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Chemisches Central-blatt.
No. 7, 1880.

New Method for Recognising the Optical Difference of Transparent Bodies.—V. Dvorák.—The author describes a new method and a simple apparatus by which the differences of transparent bodies due to the inequality of the indices of refraction may be distinguished. The method has certain advantages as compared with that of Toepler (*Pogg. Annalen*, 131, 33), and the apparatus is extremely sensitive.—*Casopis pro Péstování Mathem. a Fysiky*, ix., 23 to 31, Agram.

Contributions to Quantitative Spectral Analysis.—C. von Norden.—This memoir treats of a simplification introduced into Hüfner's spectro-photometer; on the determination of the degree of concentration of a normal solution, and certain observations with oxyhæmoglobin from the blood of dogs, guinea-pigs, and rats.

Examination of "Ferrum Hydrogenio Reductum."—G. Vulpius.—*Arch. Pharm.*, xv., 508, Dec., 1879.

Volhard's Volumetric Determination of Silver.—H. v. Jüptner.—The author finds the results of this process accurate to 1 part in 2000.—*Oest. Zeit.*, xxviii., 33.

Erroneous Test for Kirshwasser.—G. A. Berchelmann.—The blue colouration produced with guiacum wood is merely due to the presence of traces of copper derived from the still, and throws no light upon quality.—*Arch. Pharm.*, xv., 517.

Analysis of Milk.—N. Gerber and P. Radenhausen.—The authors consider that the measurement of milk does not give accurate results, and that for the determination of total solids it is better to dry up after coagulation with alcohol or acetic acid than to dry along with sand. The determination of the albuminates is best effected by coagulation with copper sulphate, neutralisation with soda-lye, and removal of fatty matter from the coagulum. They determine milk-sugar by titration with Fehling's solution. Feser's lactoscope gives unsatisfactory results.—*Schweitz. Zeit. f. Pharm.*, 1879, 37.

No. 8, 1880.

The Reducing Properties of Potassic Ferro-oxalate.—J. M. Eder.—This compound is prepared by mixing a concentrated solution of ferrous sulphate with a neutral concentrated solution of potassic oxalate till the precipitate first formed re-dissolves to a clear deep red liquid. The solution acts more energetically than all other acid or neutral ferrous salts, and in its action approaches the alkaline pyrogallates.—*Wiener Anzeiger*, 1880, 15.

No 9, 1880.

The Acid Reaction of Cryolite.—F. Stolba.—The author finds that powdered cryolite reddens moist litmus paper.—*Listy Chem.*, iv., 67.

No. 10, 1880.

The Source of the Force Exciting Electricity.—Every heat-phenomenon, emission as well as absorption, occasions under favourable circumstances an electric current. The current produced by the emission of heat has the opposite direction from that produced by absorption. If only one metal in a galvanic element is active, the electric force is proportional to the algebraic sum of the heat developed by the bodies acting upon each other within the element. If both metals are active the electric force is proportional to the difference of the algebraic heat-sums on the one and the other side. The power of polarisation in exciting electricity depends neither on the nature of the gas nor of the metal, but mainly on the chemical action springing from electrolysis. The power of two metals in one acid to produce electricity stands in a simple proportion to the heat which the metals in question evolve when they unite with the acid to form salts.—*Rad. Jugosl. Ak.*, L. 1 to 31.

Morphine Hydrochlorate.—H. Tausch.—Commercial morphine hydrochlorate if heated to 130° turns brown and undergoes a partial decomposition.—*Wiener Anzeiger*, 1880, 20.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 11, March 11, 1880.

This issue is chiefly taken up with an account of the prizes awarded by the Academy of Sciences.

NOTES AND QUERIES.

Tension of Dissociation.—Can any of your readers inform me what meaning Deville attaches to the term "tension of dissociation"?—H. G.

Sulphur in Coal.—In reference to Dr. Wallace's observation as to the existence of sulphur in coal more than sufficient to form FeS_2, it is stated by Wittstein in *Archiv. d. Pharm.*, 1876, that sulphur is generally present in coal in greater quantity than is necessary for the formation of pyrites.—F. I. C.

Blue-black Writing and Copying Ink for Hot Climates.—(Answer to "South Africa.")—The following prescription will make a good ink:—Aleppo galls, 4½ ozs.; bruised cloves, 1 drachm; cold water, 2 pints; best copperas, 1½ ozs.; pure sulphuric acid, 35 minims.; sulphate of indigo, as neutral as possible, ¼ oz. Digest the galls and cloves for a fortnight in the water, shaking frequently; filter through paper, add the copperas to the filtrate, and, when dissolved, the other ingredients.

MEETINGS FOR THE WEEK.

TUESDAY, 18th.—Civil Engineers, 8.
—— Pathological, 8.30.
—— Royal Institution, 3. Mr. Fiske, "American Political Ideas."
—— Society of Arts, 8. Rev. James Sibree, Jun., F.R.G.S., "The Arts, Commerce, Recent Advances, and Future Prospects of the Island of Madagascar."
WEDNESDAY, 19th.—Society of Arts, 8. Lieut. G. T. Temple, "Trade Routes between England, Norway, and Siberia."
—— Meteorological, 7.
THURSDAY, 20th.—Royal Institution, 3. Mr. T. W. R. Davids, "Buddhist Sacred Books."
—— Pharmaceutical (Anniversary), 8.
—— Society of Arts, 8. Capt. Abney, R.E., F.R.S., "Some Recent Advances in the Science of Photography."
—— Chemical, 8. Miss Lucy Holcrow and Dr. E. Frankland, "On the Oxidation of Peaty Matters." Discussion on Dr. Tidy's Paper on "River Water."
FRIDAY, 21st.—Royal Institution, 8. Mr. W. Spottiswoode, "Electricity in Transitu," 9.
—— Society of Arts, 8. A. Terrien de la Couperie, "China and the Chinese: Their Early History and Future Prospects."
SATURDAY, 22nd.—Royal Institution. Prof. Morley, "The Dramatists before Shakespeare," 3.
—— Physical, 3.

TO CHEMICAL MANUFACTURERS AND PARTNERSHIP AGENTS.

RE JOHN GELLATLY, IN LIQUIDATION.

TO BE SOLD as a Going Concern, by Private Treaty, the whole of the Stock, Plant, Utensils, Goodwill, and Possession of Hawkesbury Lane Chemical Works, near Coventry, lately carried on by Messrs. Gellatly and Farr. Or an advantageous partnership may be arranged with the present solvent Partner.

Full particulars on application to the undersigned, at his Offices, 30, Hertford Street, Coventry.

CHARLES F. BARNARD, Trustee.

THE CHEMICAL NEWS.

VOL. XLI. No. 1069.

ON THE

PRESENCE OF NITROGEN IN IRON AND STEEL.*

By ALFRED H. ALLEN, F.C.S.

ALTHOUGH numerous chemists have investigated the vexed question of the presence of nitrogen in commercial iron and steel, their results have been very contradictory, and the problem cannot be said to have hitherto received a definite solution.

As tests for or modes of determining nitrogen in iron and steel the following principles have been utilised :—

1. The metal has been ignited with soda-lime or potash-baryta, the object being to convert the nitrogen into ammonia. (Schafhäutl, Marchand.)
2. The metal has been heated to redness in a current of hydrogen, with the object of converting the nitrogen into ammonia. (Fremy, Stuart and Baker.)
3. The metal has been dissolved in acid, and the resultant ammonia distilled off after addition of an alkali. (Boussingault, Bouis.)
4. The metal has been converted into oxide by igniting it *in vacuo* with oxide of copper, the liberated nitrogen being measured as gas. (Schafhäutl, Marchand.)
5. The metal has been ignited in admixture with native sulphide of mercury, and the liberated nitrogen gas measured. (Boussingault.)
6. The metal has been ignited with potassium or sodium, whereby a cyanide was formed which admitted of easy and certain recognition. (Marchand.)

In 1865 Stahlschmidt prepared a definite nitride of the formula N_2Fe_4, and concluded that nitride of iron existed in an irregular state of distribution in commercial steel.

Since 1865 I am not aware that the question of the presence of nitrogen in steel has been investigated from a chemical point of view, though the matter has been touched upon by Mr. John Parry, who, in a research on the gases occluded in iron and steel, incidentally found that nitrogen was not present to any appreciable extent in a specimen of grey cast-iron.

Among the most promising and convenient of the methods of searching for nitrogen in steel are those based on its combination with hydrogen, and consequent conversion into ammonia. As, however, the tendency of hydrogen to combine with nitrogen is not very great, and is greatly diminished at a red-heat, it is desirable to arrange the experiment so as to reduce these disadvantages to a minimum. This was not done by those chemists who sought for nitrogen by heating the steel to redness in a current of hydrogen ; for, apart from the limited tendency to form ammonia under such conditions, the temperature employed was such as might not improbably lead to the establishment of a reversed action, and the consequent decomposition of any ammonia previously found.

* A Paper read before the Chemical Society. Communicated by the Author.

With a view of avoiding these difficulties it occurred to me that the tendency of any nitrogen in the steel to form ammonia would be much increased by presenting the hydrogen to it in a nascent state, and in a neutral atmosphere which should rapidly remove the products from the sphere of action. These conditions are exactly fulfilled if the hydrogen be obtained in a nascent state by heating the steel to be tested for nitrogen in a current of steam, when the following reaction might be supposed to occur :—

$$3Fe_4N_2+16H_2O=4Fe_3O_4+6H_3N+7H_2.$$

This reaction appeared to possess the additional advantages of requiring only one reagent (vapour of water), of allowing a complete expulsion of the air from the apparatus, and of affording a very convenient means of collecting any ammonia formed.

In accordance with these views I have made a series of experiments with the following arrangement of apparatus :—

A, B, C (Fig. 1) is a combustion-tube about seven feet in length. It is thoroughly cleaned; a plug of ignited platinum gauze is inserted at B, and the part of the tube from B to C is filled with the material to be operated upon, in as fine a state of division as possible. Another platinum gauze plug is inserted at C. At D, the tube is joined by a sound cork to the large retort E, containing water to which a few drops of hydrochloric acid and fragments of steel borings have been added. The object in making these additions is to retain any trace of ammonia in the water, and to facilitate the expulsion of the last traces of air by causing a slight evolution of hydrogen. The tubulure of the retort is fitted with a cork carrying a bent glass tube, F, tightly closed at the farther end by a piece of elastic tubing and a screw clip. Before heating the water in the retort this tube is entirely emptied of air by loosening the clip and sucking up the water till filled with it. A little beyond B the combustion tube is bent, and surrounded at its further extremity by the Liebig's condenser, G, through which a rapid current of cold water can be maintained by means of the tubes H H, connected with the source of supply.

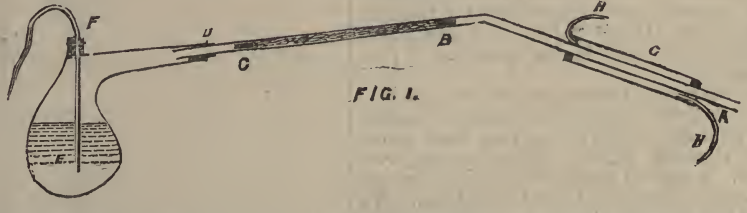


FIG. 1.

A number of experiments have been made with this apparatus, but the following are those of the greatest interest and importance :—

Action at a Red-heat of Vapour of Water on Bessemer Steel.—From 50 to 200 grms. of Bessemer steel have been placed in the part of the tube from B to C. In every case the borings were first heated to dull redness in a muffle, to get rid of any trace of grease or ammoniacal salts. The retort has next been attached, and the water in it caused to boil vigorously by a lamp placed underneath. As soon as the whole apparatus became hot, and uncondensed steam was issuing freely from the open end of the tube at A, cold water was allowed to circulate through G, and the condensed water collected in glass cylinders. Notwithstanding all the precautions taken to prevent the accidental introduction of traces of ammonia, the first portions of the distillate have usually shown distinct traces of colour when examined by Nessler's method.* This, of course, is an exceedingly delicate test, but I have always continued the operation till the condensed water shows no yellow colour in addition of the reagent, and is consequently free from even the faintest trace of ammonia, or any substance

* I do not think this colour has always been due to the presence of ammonia as an impurity. From the experiment with artificial nitride of iron, it is not improbable that the ammonia is actually produced by the incipient action of the steam at 100° C.

capable of simulating it. On reaching this point the operation has been in progress a considerable time, so that every trace of atmospheric air must have been expelled from the retort and posterior part of the tube by the continuous and rapid current of steam transmitted. The portion of the tube containing the steel borings has next been heated to redness by a Hofmann's combustion-furnace placed outside it. On reaching an incipient red-heat a formation of ammonia at once occurs, and the condensed water gives a deep brown colour with Nessler's test. This effect soon reaches a maximum, and ammonia continues to be found in the distillate as long as the oxidation of the iron continues, whereas, if it were due to occluded nitrogen, or to an unexpelled trace of atmospheric air, it would be anticipated that the formation would be of a very temporary character. As a fact, I have never succeeded in oxidising the steel borings throughout (though I have continued the current of steam for as long a time as six hours), and as a consequence have never got to the end of the production of ammonia.

In addition to the reaction with Nessler's reagent, the condensed steam has been proved to contain ammonia by the following absolutely conclusive reactions:—

1. On re-distilling the condensed water the first portions have a distinct smell of ammonia, and marked alkaline reaction to litmus-paper. 2. On acidifying the re-distilled liquid with hydrochloric acid, and evaporating it to dryness in platinum with platinic chloride, a sensible amount of yellow precipitate is obtained, having the characteristic crystalline form of ammonium chloroplatinate.

I produce a tube containing 0·1185 grm. of the yellow salt. It was produced from Bessemer-steel borings, and contains 0·0072 grm. of nitrogen. This amount is as great as that contained in 7·2 cubic centimetres, or 0·44 cubic inches of air.

I need scarcely add that the accidental retention of so large a volume of air in the apparatus is perfectly inconceivable; and even if present, only a minute fraction of its nitrogen would be likely to undergo conversion in ammonia.

I regard the experiment last described as absolutely conclusive as to the presence of a small proportion of nitrogen in the steel operated on. It will be observed that steam was the only reagent employed in the operation of producing the ammonia.

Freedom from Nitrogen of Iron reduced by Hydrogen.—The apparatus already described was in one case arranged in the usual way, but the portion of the tube from B to C was filled with recently ignited, finely granular, red hæmatite iron ore. A current of steam was passed through the apparatus, and the hæmatite heated to redness. No trace of ammonia was found in the condensed water. The tube F was then attached to an apparatus in which hydrogen was evolved by the action of Bessemer-steel on hydrochloric acid, the gas being perfectly free from any trace of ammonia or atmospheric air. As soon as the hydrogen was found to be escaping freely from K, the water in the retort was allowed to cool down. The current of hydrogen was passed continuously over the red-hot hæmatite until the latter was supposed to have suffered complete reduction to the metallic state; the water in the retort was again boiled, and, when it commenced to distil, the current of hydrogen was arrested, and the reduced iron re-oxidised by the steam. The condensed water from K *contained no trace of ammonia* when examined by Nessler's test. The negative result is important, for while proving the freedom from nitrogen of the iron reduced from the oxide by hydrogen, it shows that the ammonia obtained from the Bessemer steel was not a constant accompaniment of the operation, and hence was really due to the presence of nitrogen in the steel, and not to some accidental source.

Nitride of Iron.—With a view of ascertaining the behaviour of undoubtedly nitrogenised iron when treated in the apparatus, I prepared a quantity of nitride of iron by heating to redness a quantity of very thin soft iron wire in dry ammonia gas. The product was of a dark grey colour and extremely brittle. It contained about 2½ per cent of nitrogen, and evolved abundance of ammonia when heated with slaked lime.

Some of the substance was placed in water acidulated with hydrochloric acid, well washed, heated to dull redness in the air, and then placed in the apparatus. On passing a current of steam over it at 100° C., the condensed water contained a sensible quantity of ammonia which did not apparently diminish on continuing the experiment for some hours. On heating the nitride of iron to redness (the current of steam being continued), a large quantity of ammonia was formed, and the production continued regularly for four hours, when the experiment was arrested. The formation of ammonia at 100° C. is doubtless due to the incipient decomposition of nitride of iron when heated at that temperature in a rapid current of steam.*

Formation of Ammonia by the Solution of Steel in Acid.—The solution of steel in hydrochloric acid affords the most convenient and satisfactory means of converting the contained nitrogen into ammonia. The method was originally employed by Boussingault, but since the date of his researches analytical chemistry has been enriched by the discovery of the extraordinarily delicate reagent for ammonia known as "Nessler's test," and hence the examination of steel and iron for nitrogen, and the determination of the amount present, can now be satisfactorily carried out on as small a quantity as one gramme of the metal—a circumstance which has greatly facilitated the execution of the somewhat extensive series of experiments about to be described.

One grm. of the sample of iron or steel to be examined is weighed out and heated to incipient redness in a porcelain crucible. While still hot it is tipped from the crucible into the flask A (Fig. 2), which contains a small quantity

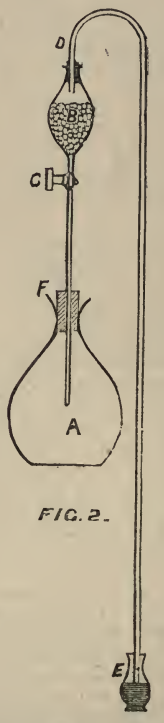


FIG. 2.

of ammonia-free distilled water. The cork F is next inserted, and with it the tapped bulb and tube B C. B contains a number of recently ignited glass beads. The water in the flask is then boiled for some minutes, till steam

* Stahlschmidt found that nitride of iron was gradually decomposed by boiling with water.

issues copiously from the open top of B and the air is judged to have been completely expelled. The tap C is then closed, and the lamp removed from under A. As the cooling proceeds the flask becomes vacuous through condensation of the steam, and any trace of air contained in the pores of the cork or elsewhere is got rid of by subjecting the water in the flask to a second boiling, followed by closure of the tap.

20 c.c. of hydrochloric acid of 1·11 sp. gr. are next poured into the bulb B, and the bent tube and india rubber cork D inserted. The tube is at least 3 feet in vertical height, and the lower end is closed by mercury. The acid in B is next boiled until all the air is expelled through the mercury, when the tap C is opened and the acid runs into the flask. By operating in this manner the metal may be dissolved without admitting the smallest quantity of air or the loss of the least trace of the ammonia formed. I may say, however, that experiment has conclusively proved that the presence of air during the solution of the metal does not cause any formation of ammonia, so that, as far as the accuracy of the results are concerned, the foregoing precautions prove to have been unnecessary. The employment of the glass beads is, of course, to prevent the escape of any traces of ammonia together with the hydrogen. To facilitate the solution of the metal, heat is applied to the flask.

When the solution of the metal is complete, the source of heat is withdrawn and the tap closed. The long tube is removed, water poured in the bulb, and allowed to enter the flask by opening the tap. The contents of the flask are then transferred to a larger flask or retort adapted to a Liebig's condenser, an excess of freshly-burned finely-powdered quicklime added, and the liquid distilled. In the distillate, the ammonia is determined by Nessler's reagent, in the same manner as in a water analysis.

Throughout the experiments made by this method, the most scrupulous care has been taken to avoid the introduction of ammonia as an impurity in either of the reagents. The distilled water was proved not to evolve any trace of ammonia when re-distilled either with or without lime. The lime itself was freshly made by re-igniting slaked lime in a muffle. The hydrochloric acid was specially prepared by passing the gas evolved on heating common salt with sulphuric acid into ammonia-free distilled water. It was also proved to be free from nitrous compounds and free chlorine. As a direct proof of the freedom of the reagents from contamination by ammonia, blank experiments were made on them at intervals throughout the series of experiments. A correction for the minute proportion of ammonia thus found has been made in all the results recorded below. But the best and most conclusive proof of the freedom of the reagents from ammonia and the harmlessness of the presence of air is to be found in the fact that *zinc*, whether in the absence or the presence of air, gave *absolutely no ammonia* on solution in hydrochloric acid.

The following numerical results have been obtained by the solution method:—

Nitrogen found in Samples of Commercial Metals.

N.B.—The determinations of nitrogen in the last column were obtained with free access of air. In all other cases the atmospheric air was rigidly excluded.

Nature of Sample.	Remarks on Sample.	Combined Carbon per cent.	Nitrogen per cent.	
			All Air excluded.	Air present.
Soft Irons—				
Thin iron wire	Matters not iron = 0·05 per cent	None	0·0123	0·0098
Swedish iron	Matters not iron = 0·13 per cent	None	0·0111; 0·0094	—
Wrought iron armour-plate	J. Brown and Co.	Traces	0·0131	0·0148
Steels—				
Siemens-Martin steel		0·22	0·0107	—
Blister steel from Swedish iron	W. Jessop and Sons	0·35	0·0148; 0·0131	0·0143
Thomas-Gilchrist steel	Brown, Bayley, and Dixon	0·39	0·0115	0·0115
Bessemer steel	Chas. Cammell and Co.	0·50	0·0164	0·0156
Siemens-Martin steel	Chas. Cammell and Co.	0·60	0·0098	0·0098
Pianoforte wire		0·62	0·0094	—
Double-shear steel	W. Jessop and Sons	1·05	0·0139	—
Crucible steel	W. Jessop and Sons	1·09	0·0082; 0·0080	0·0063
Blister steel from Swedish iron	William Hall	1·25	0·0156; 0·0156; 0·0152	0·0152
Steel from Dannemora iron	B. Huntsman	1·30	0·0172	—
Pig Irons—				
Chrome pig iron	Contains much graphite and 0·45 per cent of chromium	Traces	0·0098; 0·0094	0·0078
"Titanic plate" iron	J. Brown and Co.	1·90	0·0049	0·0043
White iron	0·15 per cent phosphorus; 0·31 per cent manganese	3·10	0·0074	—
Spiegeleisen	20 per cent of manganese	3·80	0·0041	0·0041
Various Metals—				
Aluminium foil		—	None	—
Distilled zinc	Free from lead and iron	—	None	None
Sheet nickel	Pure; Fleitmann and Witte	—	—	None
Magnesium ribbon		—	0·0020	—
Sodium		—	—	0·0011

From an examination of this table it will be seen that the experiments made in presence of air give results agreeing with those in which every precaution was taken to prevent the presence of air. I cannot say that I am personally surprised at this result, as I could see no reasons to suppose that nascent hydrogen would combine with atmospheric nitrogen below 100° C., whatever might be the case at more elevated temperatures.

Another interesting point is the fact that the samples of commercial aluminium, zinc, and nickel examined contained no trace of nitrogen, while in the magnesium and sodium* the proportions found were far less than those met with in iron and steel. No very apparent connection

* From information communicated by Dr. Carnelly I believe some samples of commercial sodium contain a notable proportion of nitrogen.

exists between the proportion of nitrogen found in iron and steel and the percentages of combined carbon, and the experiments show that the presence of nitrogen is by no means peculiar to *steel*, as distinguished from cast- or wrought-iron.

So far, I have made no attempt to establish any relationship between the proportion of nitrogen present in steel and the physical and mechanical characters of the metal, and the fact that the amounts of nitrogen hitherto found have been invariably less than 1 part in 5000 suggests the probability that the exact proportion of that element is a matter of but little importance. Nevertheless, the solution method now affords a rapid and accurate means of examining steel and iron for the amount of nitrogen contained in them, and it is probable that in certain cases the determination may prove of considerable value. Owing to the difficulty which has hitherto existed of detecting nitrogen, metallurgists have been in the habit of ignoring its probable presence in iron and steel, but there are a number of curious facts which go to indicate that nitrogen occasionally exists in steel to a very sensible extent, and the properties of nitride of iron render it probable that any abnormal proportion of nitrogen would have a very decided influence on the physical and mechanical characters of the metal. As an instance of the presence of an unusual amount of nitrogen in some form I may mention the fact observed by P. Regnard, that the freshly fractured surface of certain steel melted in the Ponsard furnace evolved an unmistakable odour of ammonia. Notwithstanding some attempts, I have not hitherto succeeded in obtaining specimens of such steels as might be suspected to contain an abnormal proportion of nitrogen, but should strongly recommend metallurgical chemists to make a determination of the nitrogen in all cases in which the mechanical characters of steel are at variance with the indications of the chemical analysis as ordinarily made.

The following conclusions are deducible from the experimental results described in the foregoing paper.

1. Commercial irons and steels contain nitrogen in such a form as to undergo conversion into ammonia by the action of steam or hydrochloric acid.
2. The solution method indicates a proportion of nitrogen in commercial iron and steel, varying from 0·0041 per cent in spiegeleisen to 0·0172 per cent in steel from Dannemora iron.
3. The solution process of estimating nitrogen gives closely concordant results on repetition.
4. The results obtained by the solution process are not affected by dissolving the metal with free access of air.
5. No nitrogen was present in the specimens of commercial aluminium, zinc, and nickel examined by the solution method, and but very small proportions were found in magnesium and sodium. Hence iron is exceptional in the proportion of nitrogen contained in it.
6. The iron reduced from the oxide by hydrogen differs from all varieties of the commercial metal by containing no trace of nitrogen.
7. No connection is distinctly traceable between the proportion of nitrogen in commercial iron and steel and that of carbon or other foreign elements.
8. There is no positive evidence as to its condition, but the probability is somewhat in favour of its existence as nitride of iron.

In conclusion I beg to express my indebtedness to Mr. Leonard Archbutt and Mr. Charles Harrison for their assistance in the experimental part of the investigation described in this paper.

Technology of the Mint.—Hermann Danert.—The copper used as an alloy must be exceedingly pure. The author gives information concerning the arrangement of furnaces and the choice of crucibles.—*Berg. und Hutten Zeitung.*

ON THE

SEPARATION OF SILICA IN THE ANALYSIS OF LIMESTONES, IRON ORES, AND OTHER MINERALS.*

By H. ROCHOLL, F.I.C., Clarence Iron Works, Middlesbough.

THE separation of silica is usually the first step in analysing minerals containing it. If possible, the mineral is decomposed by hydrochloric acid, evaporated to dryness, and then treated with hydrochloric acid and water. Silica in the insoluble condition, and the bases as soluble chlorides, are thus obtained, and these are separated by filtration.

Many silicates, however, do not yield to this treatment, prominent amongst them being clay. This silicate of alumina is hardly ever absent as a more or less intimate admixture in such samples of limestones, iron, and manganese ores, and other minerals, as occur for manufacturing processes. Consequently, if silica be present in the form of clay, or any other not decomposable silicate, the insoluble residue referred to above is not pure silica, but contains alumina or other bodies. Professor Percy, in the analyses of British iron ores which were made in his laboratory, and are given in his "Metallurgy of Iron," examined separately the soluble and the insoluble part of the samples. On referring to these tables, it will be found that the insoluble residue is, with one exception, never pure silica, but contains alumina, and mostly also other bases. If the quantity of insoluble substance be small, say below 2 per cent, and iron and certain rarer bodies are known to be absent, we may safely, unless absolute accuracy is required, treat it with hydrofluoric and sulphuric acids, ignite, and assume the difference to be silica, the residue being alumina. If the appearance of the insoluble matter be that of pure quartz, we may take it to be all silica.

For more accurate analysis, however, and when the insoluble residue is considerable in quantity, either the whole of the sample under treatment, or the insoluble part, must be fused with sodium carbonate, or some other basic flux, in order to obtain a more basic compound, which is readily decomposed by hydrochloric acid. This way of proceeding has two drawbacks, which, whenever possible, are eschewed by the analyst, viz., considerable expenditure of time and the introduction of a considerable quantity of foreign matter into the substance under examination.

Now, in the method which I am desirous to bring before this Institute, I propose to utilise as flux the bases present in the mineral itself. I prepare, by mere ignition, a basic silicate decomposable by hydrochloric acid.

As regards *limestones*, we have successfully treated in the Clarence laboratory specimens containing up to 21·2 per cent silica and 6·5 alumina, care being taken to prove the purity of the silica obtained. I utilise in this case the same portion of the finely powered sample which has served for the determination of water and carbonic acid by ignition in a platinum crucible. It is transferred into a dry basin, and carefully treated with a little water; the lime left in the crucible is then washed into the basin with water and hydrochloric acid, and more acid added until solution has taken place. The evaporation to dryness is then quickly effected, as only small quantities of liquid have to be employed. The silica obtained is perfectly pure

For the analysis of *ores* a somewhat more circuitous procedure is necessary, as the sample after ignition has to be re-weighed and re-powdered. I proceed as follows:—I weigh out into a tared platinum crucible a quantity of the finely powdered sample, something more than what is required for actual analysis; then ignite, at first gently, afterwards for about twenty minutes, to nearly a white heat, either in a good muffle or within a clay jacket over

---

* A Paper read before the Iron and Steel Institute.

a strong blowpipe flame. An incipient fusions hould take place. I re-weigh and carefully detach as much as possible from the crucible; this will be effected easily if the substance before ignition had been pressed into one corner of the crucible, and not spread over the bottom. The mass will be found exceedingly hard, and is best treated by being at first roughly pounded in a steel mortar and then finished in an agate or wedgewood mortar.

In weighing out a portion for analysis, an allowance may be made in proportion to the loss sustained in the ignition, so that subsequently calculations may be made on the weight usually taken for analysis. The power is then digested in a porcelain dish with strong hydrochloric acid. If the treatment has been successful, a clear jelly or solution will readily form, and the analysis can be proceeded with in the ordinary way.

The ignited silica may still contain certain impurities in small quantities. Titanic acid has to be looked for in certain iron ores, and barium sulphate in manganiferous ores; indeed, I have met with a red hematite which contained 19 per cent of the latter body. It is advisable, in the presence of baryta, to precipitate it completely as sulphate before filtering the silica. The ignited residue, on treatment with hydrofluoric and sulphuric acids, will leave the whole of it, the difference being silica. The residue may be examined for titanic acid by the known methods.

The applicability of this method is limited by the percentage of silica. I have been successful with ores containing up to 25 per cent of silica, but not with an ore containing 31 per cent. The latter was a magnetic ore, containing 41 per cent of iron; the gangue consisted of quartz, greenstone, and garnet. In order to try if the want of success was merely owing to the excessive amount of silica, and not to the nature of the compounds, as which in this case it occurred, I added to a fresh portion 50 per cent of ferric oxide, so bringing the silica down to about 21 per cent. After ignition, I obtained a mass which was readily decomposed, even in rough lumps.

Calcined Cleveland mine, a very heterogeneous mixture of numerous compounds, which does not even yield the whole of its iron to hydrochloric acid, is readily decomposed after semi-fusion of the finely powdered sample.

The platinum crucible, after use, is best cleaned by fusing some sodium carbonate in it. Although hydrochloric acid slowly dissolves whatever adheres to the sides, its use is better avoided on account of the possible presence of manganese.

My experience with this method has been confined to the class of minerals specified; but it may undoubtedly be made useful for the analysis of many others, impure carbonates, and such as are chiefly of a basic character.

The idea of letting the base contained in the mineral act as a flux for its impurities seems so readily to suggest itself that other chemists may have been employing it, particularly for limestones, where its advantages are greatest. However, I have not seen it mentioned in recent editions of standard books on analysis, or in any technical periodicals; and having found it of practical value, I have ventured to lay it before the Institute, hoping it may help to banish from chemical analysis that unchemical body insoluble residue.

THE METALLURGICAL CHAIR AT THE ROYAL SCHOOL OF MINES.

THE resignation of Dr. Percy, who has so long and so creditably held the Professorship of Metallurgy at this institution, has excited more attention upon the Continent than at home, and has been pronounced by the *Revue des Mines* a loss not to England alone, but to the civilised world. To find a worthy successor for a man of such eminent merit is admittedly no easy task. Metallurgy, like every other department of applied [science, — or perhaps it would be better to say of scientific art—has very much altered its character within the last quarter of a century. It has rejected the old routine processes handed down from the middle ages, or perhaps even from Phœnician days. Instead of merely presenting the pupil with a number of empirical procedures, it lays before him principles based upon exact scientific data, and hence capable of being adapted to those varying circumstances which ever and anon put the rule-of-thumb school to utter rout. The modern metallurgist is required to work with advantage ores which his predecessors neglected, and even to obtain valuable results from the old waste-heaps of former days. He has to eliminate those foreign ingredients which even in minute traces often seriously detract from the utility of a metal and reduce its market value. He is called upon to reduce the working cost of his operations by obtaining from fuel the fullest amount of duty it is able to yield. In view of future legislation on the "Noxious Fumes Question" he is expected to limit the escape of gases and volatile matters which may be injurious to animal and vegetable life. In short, his tasks are from year to year growing in delicacy and complexity. To undertake a professorship like that vacated by the resignation of Dr. Percy is therefore a most serious responsibility. To follow in the footsteps of such a predecessor, and to continue his work in a manner advantageous to science and honourable to the nation, a man of exceptional attainments is required. He should be profoundly versed both in physics and chemistry. He must possess abundant mental resources, and, above all, he must be capable of looking at every problem—every difficulty—from a point of view at once thoroughly practical and truly scientific.

But whilst thus fully estimating the importance of the position to be filled, we think that we may congratulate our readers and the nation at large on the selection that has been made. Mr. W. Chandler Roberts, the professor-elect, has fully won his spurs in chemical and physical research. We need merely mention his investigations on the use of the spectroscope in the quantitative analysis of metals. His successful connection with Her Majesty's Mint has given him a wide experience in many of the most delicate metallurgical questions, and affords the surest guarantee for his satisfactory discharge of the duties of his new position.

We feel perfectly satisfied that his department of the School of Mines will be conducted as all true friends of Science and of our national industry could wish.

PROCEEDINGS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

Annual Meeting, Saturday, May 1, 1880.

Mr. GEORGE BUSK, F.R.S., Treasurer and Vice-President, in the Chair.

THE Annual Report of the Committee of Visitors for the year 1879, testifying to the continued properity and efficient management of the Institution, was read and adopted. The real and funded property now amounts to nearly £85,000, entirely derived from the contributions and donations of the members. Forty-nine new members paid their admission fees in 1879. Sixty-seven lectures and Twenty Friday evening discourses were delivered in 1879. The books and pamphlets presented in 1879 amounted to about 278 volumes, making, with 509 volumes (including periodicals bound) purchased by the Managers, a total of 787 volumes added to the Library in the year.

Thanks were voted to the President, Treasurer, and Secretary, to the Committees of Managers and Visitors, and to the Professors, for their services to the Institution during the past year.

The following gentlemen were unanimously elected as Officers for the ensuing year :—

President—The Duke of Northumberland, D.C.L.,LL.D.

Treasurer—George Busk, F.R.C.S., F.R.S.

Secretary—Warren De la Rue, M.A., D.C.L., F.R.S.

Managers—The Earl Bathurst; George Berkley, M.I.C.E.: William Bowman, F.R.S., F.R.C.S.: Thomas Boycott, M.D., F.L.S.; Frederick Joseph Bramwell, F.R.S.; Joseph Brown, Q.C.; The Earl of Derby, M.A., LL.D., F.R.S.; Capt. Douglas Galton, C.B., D.C.L., F.R.S.; Hon. Sir Wm. R. Grove, M.A., D.C.L., F.R.S.; Cæsar Henry Hawkins, F.R.S., F.R.C.S.; William Watkiss Lloyd; Henry Pollock; John Rae, M.D., LL.D.; Robert P. Roupell, M.A., Q.C.; James Spedding.

Visitors—George B. Buckton, F.R.S., F.L.S.; Stephen Busk; The Lord Sackville Cecil; George Howard Darwin, M.A., F.R.S.; William Henry Domville; James N. Douglass; Right Hon. The Lord Claud Hamilton; Alfred G. Henriques; Robert Mann, M.D., F.R.C.S.; John Fletcher Moulton; William Henry Preece, M.I.C.E.; Lachlan Mackintosh Rate; James Romanes; Hon. John Gage Prendergast Vereker; Edward Woods, M.I.C.E.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

Ordinary Meeting, April 19, 1880.

Mr. J. MACTEAR, F.C.S., F.I.C., President, in the Chair.

THE PRESIDENT read a paper translated from the French of M. EUGÈNE PLANCHUD, "*On the Formation of Sulphuretted Mineral Waters.*" The observations and experiments of the author showed the presence of sulphur in mineral waters to be due to the reducing action of living vegetable matter on the sulphates contained in these waters. On examining under the microscope the long delicate threads found clinging to the stones in the neighbourhood of sulphur springs, and which are generally supposed to be threads of sulphur, the author discovered them to be composed of hollow cylindrical tubes matted together. Most of these tubes were filled with spores, which, when liberated, moved about with a rapid motion, finally came to rest, and developed hair-like processes similar to those from which they had been discharged. M. Planchud conjectured these hair weeds to be the cause, and not the consequence of the sulphur in the water. To prove this he made the following experiment :—He filled three flasks with a solution of sulphate of lime. Into one of these he put dead organic matter; into the other two, hair-weeds obtained from a sulphur spring. One of the two flasks containing the hair-weeds he boiled to destroy the life of the weed and its spores. All three flasks were then sealed hermetically, and allowed to stand under similar conditions. On opening them it was found that only the flask containing the living hair-weeds gave off sulphuretted hydrogen. The other flasks remained unchanged during several months. At the end of six months, however, the flask into which the dead organic matter had been put was found to smell faintly of sulphuretted hydrogen, and on examination hair-weeds were found in it.

The PRESIDENT next read a paper "*On the Action of Concentrated Sulphuric Acid on Various Qualities of Lead.*" The question of the action of sulphuric acid on lead is one that every now and then forces itself strongly upon the attention of the chemical manufacturer, and usually causes him not a little trouble and loss ere the matter is set aside for the time.

Within recent years various changes have been made in the methods of refining the various qualities of lead, and some at least of the manufacturers of sheet and pipe lead are using brands of pig-lead, which formerly they did not employ. It is owing to these changes no doubt that there has been within the last few years so much more trouble with the leaden pans used in concentrating vitriol.

The subject of the action of concentrated sulphuric acid on lead has been investigated by various chemists, notably by Calvert and Johnson. They exposed plates of lead of 1 square metre to the action of sulphuric acid for periods of ten days, and then estimated the amount of sulphate of lead which had formed. The following table gives the results of their experiments :—

Lead operated on Contained.	A. Ordinary.	B. Virgin.	C. Chemically pure.
Pb	98·8175	99·2060	100
Sn	0·3955	0·0120	—
Fe	0·3604	0·3246	—
Cu	0·4026	0·4374	—

1 square metre treated with 16 litres of pure sulphuric acid for ten days gave the following quantities of sulphate of lead :—

Experiment.	Sp. Gr. Acid used.	A.	B.	C.
1.	1·842	67·70	134·20	201·70
2.	1·705	8·35	16·50	19·70
3.	1·600	5·55	10·34	16·20
4.	1·526	2·17	4·34	6·84
Two experiments made with ordinary commercial acid gave—				
5.	1·746	49·67	50·84	55·00
6.	1·746	51·91	54·75	57·41

The result is that lead is all the more acted on the purer it is, and that an energetic action only takes place above the sp. gr. of 140° T.

Mallard (*Bull. Soc. Chim.*, 1874, ii., p. 114) experimented with lead containing :—Lead, 99·62; antimony, 0·14; iron, 0·03; not estimated, 0·21; and with ordinary commercial sulphuric acid. At a strength of 148° T., and the corresponding boiling-point, 205° C., it acts on the lead, yielding SO_2 and $PbSO_4$. Above 148° T., and up to 166° T., at the same time sulphur is formed

$$(SO_2+2Pb=S+2PbO).$$

Hasenclever employed very pure soft lead from Mechernich with 99·9941 Pb, 0·0006 Ag, 0·0008 Cu, 0·0040 Sb, 0·0005 Fe, which he heated in a flask with acid of 120° T. Already at 40° C. small gas bubbles rose the lead; at 80° C. a perceptible evolution of hydrogen and H_2S took place, and this increased at higher temperatures. The same lead melted up with some pure antimony and again exposed to pure vitriol of 120° T., caused at 85° C. only a scarcely visible; at 100° C., a just perceptible; and not below 140° C., a strong evolution of gas. This agrees with Calvert and Johnson's experiments.

Lastly, Bauer has examined this matter. He employed several alloys of certain composition and vitriol at 170° T. When the acid already contained lead sulphate a higher temperature was required for the action. The results were as follows :—

1. Pure Lead.—0·2 grm. heated with 50 c.c. acid of 170° T. First sensible evolution of gas at 175° C.; stronger at 190° C. At 230° to 240° C. suddenly all the lead is changed into sulphate, which dissolves in the acid, SO_2, H, and H_2S being observed.
2. Lead and Bismuth.—(*a*) 90 Pb, 10 Bi; action beginning at 150°, goes on slowly and quietly up to 190°, when all the metal is decomposed. (*b*) 96 Pb, 4 Bi; decomposition quicker than in *a*; terminated at 130° to 140° C. (*c*) 99·27 Pb, 0·71 Bi; decomposition rapid and sudden at 160° C.
3. Lead and Antimony.—(*a*) 10 per cent Sb; slow and even decomposition, beginning at 190° C., ending at 230° to 240° C. (*b*) 5 per cent Sb; slow decomposition, beginning at 180° to 190° C., ending at 220° to 225° C. (*c*) 1 per cent Sb; slow decomposition just perceptible at 250° C., ending at 280° C.

4. Lead and Arsenic.—10 per cent As. Process similar to the alloy with 10 per cent Sb; ended at 240° C.
5. Lead with 1 per cent copper behaves similarly to lead with 1 per cent Sb; stronger action beginning at 250° C.; all the metal dissolved at 280° C.
6. Lead and Platinum.—(*a*) 10 per cent Pt; slow incomplete decomposition, ending at 280° C. (*b*) 2 per cent Pt; sudden decomposition complete.
7. Lead with 10 per cent Tin.—Process similar to pure lead; sudden decomposition at 200° C.

From this it would seem as if small quantities of antimony and copper made the lead more resisting and as if bismuth acted the other way.

This is about all the information there is on the subject, and it is not so widely known as it might be.

Every now and then chemical manufacturers, especially those who concentrate vitriol for sale, find that their pans give way in a much more rapid manner than is at all agreeable, and in most cases no explanation is forthcoming: in all probability the new pan lasts all right, and so the opportunity is lost of examining into the cause of the damage.

Some six years ago I had a great deal of trouble with some leaden pans; they gave way one after another, sometimes only lasting for a day, and on examining the lead in the laboratory, nothing could be found to account for the rapid action of the acid; the lead seemed to be almost pure, and at that time pure lead was considered to be the great desideratum.

On heating a piece of this specimen of lead, the sheet being nearly ½" thick, in strong sulphuric acid, little action took place until the temperature approached the boiling-point of the acid, when it began violently, the lead dissolving almost as rapidly as zinc does under ordinary circumstances.

A new brand of pig-lead being used for making the next set of sheets no further trouble was experienced for a long period. About the same time, however, a number of other firms in Glasgow had experience of the same sort.

The most striking case was where a lead pipe was used for supplying the pans with acid; in three weeks the action had been so severe on the lead that it resembled more a crystalline mass with a few fibres of lead holding the sulphate of lead together.

Again, it is the practice in packing vitriol for shipment to some foreign markets, to use leaden cases of about 12" square, which are enclosed in a stout wooden case clamped with iron. It happens that if lead which is easily acted on has been used the lead gets distended with the gases produced by the action of the acid, and bursts the wooden cases to pieces, the lead case becoming sometimes as round as a ball. Some very nasty explosions have occurred through a hole being pierced in the lead cases which a light has been near, and a short time ago a plumber at Greenock was very seriously injured in this way.

More recently we have again had considerable trouble with lead pans, and after examination of the lead which gave way we found as before that it was the most pure lead which gave way. In conjunction with the manufacturer we procured a large number of different brands of lead, and these were carefully analysed by my assistant, Mr. Hope. Shortly speaking, it was found that the soft pure leads gave way soonest, while the leads containing antimony or copper stood the action of the acid best. Of two samples, one containing 0·15 per cent copper apparently stood as well as one containing 0·45 per cent antimony.

It would be an interesting study, had one time to devote to it, to ascertain what bearing the relative electrical condition of the metals has to do with this subject. Less is required of copper, a good conductor slightly negative to lead, than of antimony, a bad conductor considerably more negative to lead.

The simplest safeguard against risk of pans, &c., giving way would seem to be the careful testing of the lead prior to its being made into sheets, &c. For this purpose it will not be necessary to make an analysis, but simply to cut thin clean shavings of the lead to be tested and place them in pure cold vitriol in a test-tube; the amount of the action is clearly visible, and a comparison can easily be made of the relative value of the samples.

ANALYSIS OF LEAD.

Kind.	Lead.	Tin.	Copper.	Iron.	Zinc.	Total.
Pans which were not good—						
	99·87	0·030	0·050	nil	nil	99·95
Pans, good	99·77	nil	0·040	nil	0·16	99·97
Boxes, bad	99·82	0·120	0·030	nil	0·03	100·00
Sheet for pans—						
	99·805	0·025	0·070	nil	0·16	100·06
Sheet in stock—						
	99·884	nil	0·052	0·008	0·056	100·00
Pipe (in use for long time)—						
	99·79	0·030	0·030	nil	0·120	99·97
Sheet ..	99·89	0·021	0·048	nil	0·077	100·036
Stolberg..	99·963	trace	0·012	0·007	0·018	100 000
E. M. S...	99·924	nil	0·027	0·012	0·037	100·000
Saxony ..	99·810	nil	0·100	nil	0·090	100·000
Lead Hills	99·75	nil	0·150	nil	0·100	100·000
Mechernich	99·924	nil	0·005	0·007	0·064	100·000
La Cruz..	99·870	nil	0·066	nil	0·074	100·01
Llanelly..	99·880	nil	0·040	0·014	0·088	100·02

NOTES.—Lead Hills dissolved least in cold sulphuric acid, and the Mechernich dissolved most. The others dissolved quick in inverse proportion to the copper.

The Lead Hills contains 5·4 ozs. silver per ton = 0·015 p.c.
The Mechernich ,, 0·25 ,, ,, ,, = 0·0007 ,,

CORRESPONDENCE.

DEPHOSPHORISATION OF IRON.

To the Editor of the Chemical News.

SIR,—Referring to my letter which you kindly inserted in the CHEMICAL NEWS, vol. xl., p. 228, I take the liberty of again troubling you with a few further remarks and calculations. When a charge of cast iron is blown in the converter it is well known that the metal passes from a bright red to a dazzling white colour, which to some observers appears tinged with violet. This corresponds with the appearance termed "blue heat" by Sainte-Claire Deville, and is believed by him to represent a temperature near the melting-point of platinum. This increment of temperature cannot be very accurately expressed in figures, but it may be stated with sufficient relative exactitude for our purpose. Taking Daniells' measurement of the melting-point of cast-iron, 1530° C., and assuming that the temperature of the blown metal is from 1900 to 2100° C., which I believe most metallurgists allow, we have an increase of temperature of some 400 to 500° C., due to the oxidation of certain constituents of the crude metal.

By calculations based upon the most reliable data I could obtain, I made the increase of temperature to amount to 588° C., viz., from 1650° to 2238° C. This difference is evidently excessive, the specific heats having been calculated too low, the residual products being at a very high temperature; but inasmuch as this difference of 588° C. is made up of items calculated out upon similar physical data, and although the sum of these component items may not be absolutely correct, they nevertheless bear to each other an approximatelytrue comparative value.

Now when a charge of cast iron is blown in a lime-lined converter the metalloids and manganese present are more or less burned, as also a small proportion of the iron. Referring to my calculations in your last week's number, it will be seen that—

The total number of effective heat units finally developed		=332·1
Heat units contributed by molten cast iron	=187·7	
Heat units contributed by the blast ..	= 3·5	
		191·2
Heat units contributed by combustion, &c.		140·9

$$\frac{140{\cdot}9}{0{\cdot}1484\dagger} = 949^\circ \text{ C.}$$

From the foregoing it appears that the elements oxidised contribute to the increment of temperature during the blow in the following proportions:—

2·54	p.c.	carbon	0·84 p. c.
0·08	,,	sulphur..	0·42 ,,
0·98	,,	phosphorus	29·09 ,,
1·03	,,	silicon	47·31 ,,
0·98	,,	manganese	8·22 ,,
1·68	,,	iron	14·12 ,,
			100·00 ,,

The temperature attained is made up as follows:—

1·0 Crude iron × 0·1138 sp. heat of Fe (Regnault) × 1650° C. {Temperature at which it is assumed the iron is introduced into the Bessemer.} =187·7 $\frac{187{\cdot}7}{0{\cdot}1484\dagger} = 1265^\circ$ C.

0·0098 P burning with 0·01265 O=0·02245 P_2O_5 ∴ 0·0098 P ×5708 calorific value of P (mean of Andrews and Abria) .. .. =55·9

$\frac{0{\cdot}01265\ O \times 76{\cdot}3}{23{\cdot}7}$ = 0·04072 N ×0·244 sp. heat of N × 1500° C. .. .. =14·9

0·98 per cent phosphorus 0·0098 = nett heat units 41·0 ∴ $\frac{41{\cdot}0}{0{\cdot}1484\dagger} = 276^\circ$ C.

0·0254 C burning with 0·03387 O=0·05927 CO ∴ 0·0254 C ×2473 calorific value of CO (Favre and Silbermann) .. .. =62·8

0·05927 CO × 0·245 sp. heat of CO (Regnault).. .. =0·0145

$\frac{0{\cdot}03387\ O \times 76{\cdot}3}{23{\cdot}7}$ = 0·10904 N × 0·244 sp. heat of N =0·0266

0·0411 × 1500 C =61·6

2·54 per cent carbon ∴ 0·0254 C = nett heat units 1·2 ∴ $\frac{1{\cdot}2}{0{\cdot}1484\dagger} = 8^\circ$ C.

0·0008 S burning with 0·0008 O=0·0016 SO_2 ∴ 0·0008 S × 2220 calorific value of S (Favre and Silbermann).. .. .. = 1·8

0·0016 SO_2 × 0·154 sp. heat of SO_2 (Regnault).. .. =0·0002

$\frac{0{\cdot}0008 \times 76{\cdot}3}{23{\cdot}7}$ = 0 00257 N × 0·244 sp. heat of N .. =0·0006

0·0008 × 1500° C. = 1·2

0·08 per cent sulphur ∴ 0·0008 S = nett heat units 0·6 ∴ $\frac{0{\cdot}6}{0{\cdot}1484\dagger} = 4^\circ$ C.

0·0098 Mn burning with 0·00386 O = 0·01366 Mn_3O_4 ∴ 0·0098 Mn × 1639 cal. val. of Mn (assumed to be the same as that of Fe) .. .. =16·1

$\frac{0{\cdot}00386\ O \times 76{\cdot}3}{23{\cdot}7}$ = 0·0124 N × 0·244 sp. heat of N × 1500° C. .. .. = 4·5

0·98 per cent manganese ∴ 0·0098 Mn = nett heat units 11·6 ∴ $\frac{11{\cdot}6}{0{\cdot}1484\dagger} = 78^\circ$ C.

0·0103 Si burning with 0·01178 O = 0·02208 SiO_2 ∴ 0·0103 Si × 7830 calorific value of Si (Troost and Hautefeuille) .. .. =80·6

$\frac{0{\cdot}01178\ O \times 76{\cdot}3}{23{\cdot}7}$ = 0·03796 N × 0·244 sp. heat of N × 1500° C. .. .. =13·9

1·03 per cent silicon ∴ 0·0103 Si = nett heat units 66·7 ∴ $\frac{66{\cdot}7}{0{\cdot}1484\dagger} = 449^\circ$ C.

0·0168 Fe burning with 0·0064 O=0·0232 Fe_3O_4 ∴ 0·0168 Fe×1639 calorific value of Fe (mean of Andrews and Dulong) .. .. =27·5

$\frac{0{\cdot}0064\ O \times 76{\cdot}3}{23{\cdot}7}$ = 0·0206 N × 0·244 sp. heat of N × 1500° C. .. .. = 7·5

1·68 per cent iron ∴ o 0168 Fe = nett heat units 20·0 ∴ $\frac{20}{0{\cdot}1484} = 134^\circ$ C.

$\frac{0{\cdot}06936\ O \times 76{\cdot}3}{23{\cdot}7}$ = 0·22329 N = 0·29265 air × 0·2375 sp. heat of air (Regnault) × 50° C.

(Temperature at which the air is blown in) .. .. = 3·5 $\frac{3{\cdot}5}{0{\cdot}1484\dagger} = \frac{24^\circ}{2238^\circ}$ C.

† The sum of the specific heats calculated on the respective quantities of the non-gaseous residual products.

In the following calculations I have deducted the amount of heat required to raise to 2238° C. the residual non-gaseous products of the oxidation, as well as the lime necessary to neutralise the silica, and also the magnesia and the remainder of the lime, as if they were necessary to supersaturate the phosphoric acid.

0·0098 P burning with 0·01265 O =
0·02245 P_2O_5 + 0·02481 CaO = 0·04726 $Ca_3P_2O_8$ × 0·205 sp. heat of $Ca_3P_2O_8$ = 0·0097
59·35 p.c. CaO × 0·23 slag =
0·1365 CaO − 0·02481 CaO − 0·04122 CaO = 0·07047 CaO × 0·202 sp. heat of CaO = 0·0142
5·01 p.c. MgO × 0·23 slag = 0·0115 MgO × 0·266 sp. heat of MgO = 0·0031
0·87 p.c. $CaSO_4$ × 0·23 slag = 0·002 $CaSO_4$ × 0·2 sp. heat of $CaSO_4$ = 0·0004
0·0274
0·13326 *i.e.*, 13·3 p.c per ton of metal

0·0098 Mn burning with 0·00386 O = 0·01366 Mn_3O_4 × 0·17 sp.ht. Mn_3O_4 = 0·0023
0·0103 Si „ „ 0·01178 O = 0·02208 SiO_2 + 0·04122 CaO = 0·0633 Ca_2SiO_4 × 0·214 „ Ca_2SiO_4 = 0·0135
0·0168 Fe „ „ 0·0064 O = 0·0232 Fe_3O_4 × 0·17 „ Fe_3O_4 = 0·0039
0·0197
0·10016 *i.e.*, 10 p.c. per ton of metal

1·0 Crude iron − 0·11 loss by oxidation, &c. 0·89 Fe × 0·1138 sp. heat of Fe = 0·1013
†0·1484

Initial heat of the molten metal .. .. $\frac{187·7}{0·1484-0·0274-0·0197} = \frac{187·7}{0·1484-0·0471} = \frac{187·7}{0·1013} = 1852°$ C.

2·54 per cent carbon burned to CO .. .. .. $\frac{1·2}{0·1484-0·0274+0·0197} = \frac{1·2}{0·1484-0·0471} = \frac{1·2}{0·1013} =$ 11°

0·08 per cent sulphur burned to SO_2 .. .. .. $\frac{0·6}{0·1484-0·0274-0·0197} = \frac{0·6}{0·1484-0·0471} = \frac{0·6}{0·1013} =$ 6°

0·98 per cent phosphorus .. .. $\frac{41·0-(0·0274\times 2238°\text{C.})}{0·1484-0·0274+0·0197} = \frac{41·0-61·3}{0·1484-0·0471} = \frac{20·3}{0·1013} =$ −200

1·03 per cent silicon .. .. $\frac{66·7-(0·0135\times 2238°\text{ C})}{0·1484-0·0274+0·0197} = \frac{66·7-30·2}{0·1484-0·0471} = \frac{36·5}{0·1013} =$ 360°

0·98 per cent manganese .. .. $\frac{11·6-(0·0023\times 2238°\text{ C})}{0·1484-0·0274+0·0197} = \frac{11·6-5·1}{0·1484-0·0471} = \frac{6·5}{0·1013} =$ 64°

1·68 per cent iron .. .. $\frac{20·0-(0·0039\times 2238°\text{ C})}{0·1484-0·0274+0·0197} = \frac{20·0-8·7}{0·1484-0·0471} = \frac{11·3}{0·1013} =$ 112°

Heat contributed by the blast .. .. $\frac{3·5}{0·1484-0·0274+0·0197} = \frac{3·5}{0·1484-0·0471} = \frac{3·5}{0·1013} =$ 34°

2438° C. − 200° C.
200° C.
2238° C.

After deducting the heat required to raise their non-gaseous residual products to 2238° C., the elements oxidised would contribute to the increment of temperature during the blow as follows :—

Per cent.	Heat generated. Per cent.	Heat expended. Per cent.
2·54 carbon burned to carbon oxide	= 1·99	
0·08 sulphur burned to sulphurous acid	= 1·09	
0·98 phosphorus with the basic addition requires ..		36·23
Heat producers { 1·03 silicon	= 65·22	
Heat producers { 0·98 manganese	= 11·59	
Heat producers { 1·68 iron	= 20·11	
Heat employed in raising the temperature of the blown product to 2238° C.— $\frac{2238°-1352°+34°=352°\times 100}{2438°-1852°+34°=552°}$ =		63·77
	100·00	100·00

Of the three elements, silicon, manganese, and iron, the first undoubtedly produces the greatest nett amount of heat, and, on account of its importance as a slag constituent, will of necessity be present in the charge blown. It will, however, be convenient and preferable from several points of view, to use comparatively non-siliceous iron in dephosphorisations conducted in the Bessemer converter. Certain metallurgists now assert that phosphoretic non-siliceous iron should be made specially for the operation, which presents the peculiar anomaly of putting phosphorus into the metal in order to take it out. In a letter which appeared in *Iron*, July 19, 1879, I argued in favour of employing a comparatively non-silicious poor manganiferous iron of lower percentage than what is ordinarily called spiegeleisen. This metal would be made by mixing manganiferous ores in the furnace charge and smelting with basic fluxes. Large quantities of poor manganiferous ores can be obtained at the same price per unit of manganese as per unit of iron; and an abundant supply of manganese can also be readily obtained from the great heaps of manganese cinder produced in the smelting of spiegel prior to 1877, when a basic cinder was first introduced. Of this slag many thousand tons have been made since the commencement of mangan-

ese smelting in this country, containing from 15 to 30 per cent of manganese protoxide. These slags make an excellent flux, and would be sought after like those ancient iron scoriæ which were long ago dug up and re-smelted in our island.

When Bessemerising crude metal containing 2 or 3 per cent of manganese the afterblow would be rather longer than usual, and most of the manganese present in the metal would be burnt out. A little iron would also burn, and in this manner bases having affinity for phosphoric acid would be formed in molecular contiguity with it. To increase the temperature yet further the converter should have double tuyeres, lower and upper. Through the upper tuyeres a stream of air would be injected to burn the carbonic oxide as it emerged from the surface of the decarburising metal. A very high temperature would be thus obtained, and the metal would stand pouring and casting without that tendency to set which produces the objectionable skulls of steel sometimes left in the ladle; and the refractory cinder would remain molten and pour clean from the vessel, thus avoiding the mechanical wear and tear of the lining at present incurred in its removal. Messrs. Cooper and Pink have pointed out at the recent meeting of the Iron and Steel Institute that the explosions which ensue when the spiegel is added to overblown metal do not take place when a poor manganiferous iron is subjected to the afterblow. The manganese, it is well known, induces the removal of the sulphur from the metal both in the blast-furnace and likewise in the basic-lined converter. As iron and manganese require far less air to oxidise them than the other elements present in the crude metal, the Bessemer operation will be curtailed, and less spiegel will be necessary to convert the product into steel. The converter would of course have the usual basic lining, and I do not assert that the addition of basic oxides during the blow could be altogether dispensed with.—I am, &c.,

John Hollway.

London, May 18, 1880.

AMMONIA FROM THE NITROGEN OF THE ATMOSPHERE.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xli., p. 229, there is a note signed "S. E." stating that Rickman and Thompson's patent has been anticipated by Clark and Smith's patent, No. 4650, 1878. With the two processes before one, it is difficult to tell what E. S. means by this statement: there is not the slightest resemblance between them. The end aimed at in both, of course, is the same; that is all. If he means that their process is better than ours, let them be judged on their merits, which they inevitably will be. But if E. S. means that our process is a repetition or infringement of theirs, then I can account for such a mistake only by assuming that E. S. does not know what our process is. Let us see first what they propose to be done; certainly, to me, they propose some startling things.

First, the apparatus:—A quasi retort of fire-clay, cooled round with a copper or iron pipe wherein to make superheated steam; a fire-clay tube filled with platinum-foil or platinised pumice stone, which also surrounds the retort. This is No. 1, or the ammonia furnace. The other two inventions and their appliances described in the specification not relating to ammonia I omit.

I will give their mode of procedure in their own words (p. 7, n. 35):—"One of the essential purposes of the No. 1 furnace is to heat the nitrogen of the atmosphere to as high a temperature as possible, because it is only when at an intensely high temperature that atmospheric nitrogen becomes nascent or atomic, and so is rendered capable of entering into combination."

About this sort of *nascent state* nothing need be said here; but that atmospheric nitrogen is only capable of entering into combination when at an intensely high heat does certainly not agree with the facts—all the worse for the facts, no doubt.

On page 8 (n. 15) are represented five reactions. The fifth formula shows the reaction of steam on barium cyanide to form ammonia.

Here, then, we have their process of making ammonia:—First, a cyanide is said to be formed, and this is decomposed by superheated steam, and the hydrogen and nitrogen unite to form ammonia, and all this is said to take place at an intensely high heat and at a white heat. But a cyanide is decomposed at such a heat, therefore cannot be formed at that heat, and free ammonia is irrecoverably decomposed at a red heat; therefore, there is no possibility of any being formed at an intensely high heat or a white heat.

But assuming that there is an error as regards the heat, and that ammonia is formed as set down, except the heat. It will be seen how widely different the processes are. We take our nitrogen as it is in the atmosphere, and decompose our vapour of water, not superheated steam, by means of incandescent coal-dust, not made into bricks by hydraulic pressure, but simply coal dust or slack. The hydrogen being nascent at the instant of the decomposition of the vapour of water, unites with the free nitrogen of the air and forms ammonia in the presence of chloride of sodium, which is decomposed by the ammonia. The ammonia appropriating the chlorine and taking up another equivalent of hydrogen passes off as sal-ammoniac, and is condensed as a powder or in solution. Here, then, you have the two processes. Wherein is the sameness? Moreover, we work at a comparatively low heat; Clark and Smith require an intensely high heat. We use a simple brick chamber as furnace; Clark and Smith describe a complicated and expensive structure of clay retort and tubes, copper or iron pipes, and platinum-foil or platium-black and pumice. How long this structure would hold together at the intense heat described, if ever set to work, it would not be much of a prophecy to predict. But this, of course, is no affair of mine. I only have to show that the note of E. S. is a mistake, which I think I have done.—I am, &c.,

J. B. Thompson.

May 15, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 15, April 12, 1880

Explanation of the Experiment of MM. Lontin and De Fonvielle.—M. Jamin.—The Ruhmkorff machine gives two sorts of currents, the one direct and the other inverse, which succeed each other alternatively and indefinitely at very short intervals. The direct current magnetises the disc transversely. It is to be noted that in spite of the movement which the disc may have, this magnetisation has always the same direction in space, but that it is variable in the disc. It does not adhere to the matter of the disc and cannot draw it along. But as soon as the direct current ceases there remains in the disc a permanent magnetisation, which inheres in the matter of the disc and endows it with polarity.

Certain Compounds of the Halogens.—M. Berthelot.—The mean formation heat of iodous chloride = +41·35 cals. For iodic terchloride the mean formation heat is + 16·3 cals.; iodous bromide, + 11·9 cals.; bromous chloride, obtained by the action of gaseous chlorine and liquid bromine, gives +0·60, but if the bromine is gaseous, +4·6 cals. In the formation of iodised potassium

iodide, KI_3, from solid ingredients, the heat evolved is substantially *nil*; if the iodine is gaseous the amount = + 10·8. The corresponding bromine compound, KBr_3 (?), gives with dissolved ingredients +3·53, but with solid bromide +3·3, and with gaseous bromine + 11·5. The author calls attention to the analogy of the polyiodides and polybromides with the alkaline polysulphides and peroxides. There is a complete parallelism between the series of the sulphides or oxides of any metal and the series of chlorine, bromine, or iodine derivatives of the metal, if all these derivatives are referred to the equivalent weight of the metal. These relations are rendered manifest by the equivalent notation, whilst the atomic notation tends to mask them by obscuring the natural signification of the law of multiple proportions.

Change of Form in Glass Tubes exposed to High Pressures.—E. H. Amagat.—The author's experiments do not favour the idea that these tubes exposed to great and prolonged pressure from within undergo any change of form or size.

Certain new Experiments on Magnetic Attractions.—M. Ader.—Among the bodies examined, such as wood, paper, &c., elder-pith is most sensibly attracted by the magnet. With a Jamin magnet capable of supporting 100 kilos. the author has been able to attract a ball of elder-pith at a distance of 0·002 metre.

The Congelation-point of Alcoholic Liquids.—F. M. Raoult.—Fermented liquids freeze at a lower point than mixtures of alcohol and water of the same strength. The difference increases with the proportion of alcohol, and has about 0·10° C. for each percentage of alcohol.

Two New Sodium Silico-titanates.—P. Hautefeuille.—One of these compounds is formed of silica, 31·83 per cent, titanic acid, 52·08, and soda, 16·09. The composition of the other is:—Silica, 43·86; titanic acid, 40·00, and soda, 16·14. The chemical and crystallographical properties of both are described.

The Assay of Pyrites by the Gravi-volumetric Method.—A. Houzeau.—Inserted at length.

Formation of Tetra-methyl-ammonium Nitrate.—E. Duvillier and A. Buisine.—Juncadella proposes to prepare methylamine by causing an alcoholic solution of ammonia to react upon methyl nitrate at 100° in a close vessel. The authors use in preference a solution of ammonia in wood-spirit, avoiding thus the possible formation of ethylamine.

Natural and Mydriatic Alkaloids of Belladonna, Datura, Jusquiama, and Duboisia.—A. Ladenburg.—Belladonna contains two alkaloids, atropine, which is capable of being resolved into tropine and tropic acid, and hyoscyamine. *Datura stramonium* contains hyoscyamine, which is identical with daturine, and apparently also atropine. Jusquiama contains hyoscyamine, and a base which the author has not yet succeeded in isolating.

The Existence of Ammonia in Plants.—H. Pellet.—The author has detected ammonia in vegetable matter, such as the roots and leaves of the beet, and in wheat, in which all the magnesia present existed in the state of ammonia-magnesian phosphate. He recommends that these observations should be extended, especially noting if the proportion is modified by the addition of ammonia or of nitrogen under various forms, to the manures.

NOTES AND QUERIES.

Cyanogen.—Will any correspondent kindly inform as to a method of estimating the above quantitatively in ammoniacal liquids?—W.

White Muriate of Ammonia.—Would Mr. H. Rayner kindly give the most economical process for the manufacture of *white* muriate of ammonia of a nearly pure quality and fit for best markets?—J. T.

Gluten.—Through the medium of your journal I shall be glad to be informed of a solvent for gluten so as to become food for the yeast plant,—D. M. P.

MEETINGS FOR THE WEEK.

TUESDAY, 25th.—Civil Engineers, 8.
—— Royal Medical and Chirurgical, 8.30.
—— Royal Institution, 3. Mr. Fiske, "American Political Ideas."
—— Anthropological Institute, 8. John Milne, F.G.S., "The Stone Age in Japan." C. Pfoundes, "The Japanese People."
WEDNESDAY, 26th.—Society of Arts, 8.
—— Geological, 8.
THURSDAY, 27th.—Royal Institution, 3. Mr. T. W. R. Davids, "Buddhist Sacred Books."
—— Royal, 4.30.
—— Philosophical Club, 6.30.
FRIDAY, 28th.—Royal Institution, 8. Mr. F. Hueffer, "Musical Criticism," 9.
—— Quekett, 8.
—— Clinical, 8.30
SATURDAY, 29th.—Royal Institution. Prof. Morley, "The Dramatists before Shakespeare," 3.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

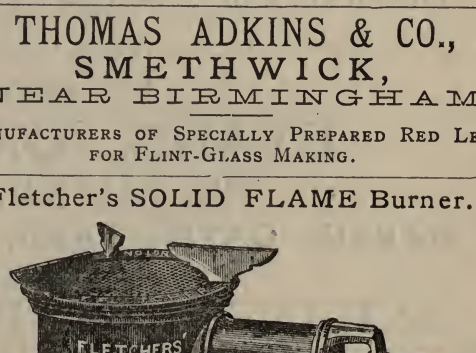
Silicates of Soda and Potash in the state of Soluble glass, or in CONCENTRATED SOLUTION of first quality, suited for the manufacture of Soap and other purposes supplied on best terms by W. GOSSAGE and Sons, Soap Works, Widnes, Lancashire.

London Agents, COSTE and Co., 19 and 20, Water Lane, Tower Street, E.C., who hold stock ready for delivery.

THOMAS ADKINS & CO.,
SMETHWICK,
NEAR BIRMINGHAM

MANUFACTURERS OF SPECIALLY PREPARED RED LEAD FOR FLINT-GLASS MAKING.

Fletcher's SOLID FLAME Burner.



The Most Perfect Heating Burner for all purposes. It will with equal ease boil an egg, or melt half-a-hundredweight of lead in an iron pot. It will boil half-a-gallon of water in a flat copper kettle in six minutes, or melt 5 lbs. lead in an iron ladle in the same time. Price, nickel plated, 5s. It can be made at a low cost of *any shape, size, or power*. New and enlarged list of Gas and Petroleum Heating Burners, Forges, Furnaces, Hot- and Cold-Blast Blowpipes, Ingot Moulds, Foot and Hand Blowers, &c., price 3d., free by post.

THOS. FLETCHER,
4 & 6, MUSEUM STREET, WARRINGTON.

TO BE SOLD.—To Brewers, Glucose, Gum, Chemical, and other Manufacturers.—Substantial and Convenient Works, with Steam Engines and Plant in excellent order; area nearly 7000 square yards; tenure almost freehold; two-thirds of the purchase money can remain on mortgage.—Apply to Mr. J. A. Harrison, Accountant, 13, Norfolk Street, Manchester.

CALVERT'S CARBOLIC ACID.

HIGHEST PRIZE MEDAL AT PARIS EXHIBITION, 1867.

GOLD AND SILVER MEDALS, HAVRE, 1868. DIPLOME D'EXCELLENCE, AMSTERDAM.

SILVER MEDAL, FIRST CLASS, NAPLES, 1871. GOLD MEDAL, MOSCOW, 1872.

F. C. CALVERT & CO., of Bradford, Manchester (original and only Manufacturers of pure Medical Carbolic Acid), beg to inform the Trade and large Consumers that their pure Medical Carbolic as well as cheaper qualities for Commercial, Veterinary, and Disinfecting Purposes, also Carbolic Acid Soaps for Medical, Toilet, and General Use, Soft Soap for Dogs, and Carbolic Acid Disinfecting Powder, may be had from any of the below-named Wholesale Agents—

Apothecaries' Soc., Lond'n	Currie & Hutchinson	Grattan & Co.	H. C. Mason	Sang & Barker
Apothecaries' Co., Glasg'w	Clarke, Bleasdale, & Co.	Hodgkinsons, Stead, & Co	May Roberts & Co.	Southall, Bros., & Co
Apothecaries' Hall, Dublin	Clay, Dod, & Case	Herrings & Co.	W. Mather	Smeeton & Co.
Allen & Hanburys	Dakin Brothers	A. S. Hill & Son	McMaster, Hodgson, & Co.	Slinger & Barnett
J. Bell & Co.	Davy, Yates, & Co.	Hodgkinsons, Preston, & Co.	J. F. Macfarlan & Co.	P. Sandeman & Co.
Barron, Harveys, & Co.	Duncan, Flockhart, & Co.	Hearon, Squire, & Francis	J. Mackay & Co.	T. & H. Smith & Co.
Barclay & Sons.	Davidson & Sim	Hirst, Brooke, & Co.	Millard, Son & Co.	Souter & Shepherd.
Burgoyne & Co.	W. Edwards & Son	W. R. Hatrick & Co.	Mackey, Sellers, & Co.	Taylor, Gibson, & Co.
Baiss Brothers & Co.	Evans, Lescher, & Evans	P. Harris & Co	Newbery & Sons	Thacker & Hoffe
Barron, Squire, & Co.	Evans, Sons, & Co.	Hunt & Co.	Paterson & Son	Jas. Taylor
Battley & Watts	Evans, Gadd, & Co.	Ismay & Sons.	Raimes & Co.	J. Thompson
Bewley & Draper	Ferris & Co.	Johnson & Sons	J. Richardson & Co.	J. Woolley, Sons, & Co.
Bainbridge & Pound	Glasgow New Apoth. Co.	Langtons, Edden, & Hicks	Raimes, Blanshards, & Co.	Wyleys & Co.
Brown Bros. & Co.	General Apothecaries' Co.	Lynch & Co.	C. Reid & Son	A .. Warre
Curling & Co.	W. & H. M. Goulding	Lofthouse & Saltmer	Sanger & Sons	
Corbyn & Co.	Goodall, Backhouse, & Co.	C. Leslie & Co.	Savory & Moore	&c., &c.
Clark & Pinkerton	Gale & Co.	Maw, Son, & Thompson	W. Sutton & Co.	

HARMOZEIN,

A NEW CHEMICAL ROUND GAME.

Packed in box, with instructions, price 3s. 6d.

JAMES WOOLLEY, SONS, & CO.

69, MARKET STREET, MANCHESTER.

DEALERS IN

CHEMICAL AND SCIENTIFIC APPARATUS, CHEMICAL REAGENTS, &c.

FOR THE USE OF

ANALYSTS, SCIENCE TEACHERS & MANUFACTURERS

Price Lists on Application

EVANS, CANT, AND CO.,

THE EASTERN CHEMICAL WORKS,

MARSH GATE LANE, STRATFORD, LONDON, E.,

MANUFACTURERS AND PATENTEES OF

ANILINE AND RESORCINE COLOURS.

WILLIAM AND WILLIAM T. FIELD,

MANUFACTURERS of the Celebrated STAFFORDSHIRE BLUE BRICKS, specially adapted for Chemical Plant, *i.e.*, Acid Towers, &c. Also all other kinds of Best Staffordshire Blue Bricks, Pavings, Plynths, Splays, Copings, &c. &c. Prices and samples on Application.

TESTIMONIAL.

"We have used the Blue Staffordshire Brick or Sulphuric Acid Towers, &c., manufactured by Messrs. Field, for the last fifteen years, during which time they have given great satisfaction. We recommend them to the Chemical Trade, believing there is nothing better in the market."—(Signed) WILLIAM HUNT and SONS, Lea Brook Alkali Works, near Wednesbury, Staffordshire, February, 1878.

TOLL END BRICK-WORKS,
TIPTON, STAFFORDSHIRE.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA.

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

JESSE FISHER & SON,
Phœnix Chemical Works Ironbridge.

CHEMICAL & PHYSICAL APPARATUS,
BOTTLES, PURE CHEMICALS,
REAGENTS, STANDARD SOLUTIONS,
And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

MOTTERSHEAD & CO.,
7, Exchange Street and 10, Half Moon Street,
MANCHESTER.

THE CHEMICAL NEWS.

Vol. XLI. No. 1070.

PROPOSED SOCIETY OF INDUSTRIAL CHEMISTS.

We learn that meetings have been held at Liverpool, Manchester, and Widnes to consider the formation of a society or institute for promoting the application of chemical science to the arts and manufactures. It will, we think, be admitted that some organisation which should afford those interested in industrial chemistry an opportunity of exchanging ideas and discussing professional questions would be of great value to the interests affected and to the trade of the country at large. Such organisations, slightly varying in their respective scopes and characters, exist abroad, and have proved exceedingly useful. But in England, manufacturing chemists hitherto have to a very great extent held aloof from each other, and have actually shunned the interchange of opinions and experience. Hence, both societies and journals of a technical character have met with very scant encouragement. But it is now very widely felt that this mutual isolation is one of the very causes which are placing our industrial eminence in jeopardy, and which, in the chemical arts as well as in other departments, are enabling foreign nations to steal a march upon us. The formation of some such society as the one proposed we should therefore regard as a hopeful sign, and should be prepared to give it every support in our power.

At the same time both its scope, its objects, and its very name should, we submit, be carefully considered and well defined. The desired association will not, of course, wish to come in collision with the Chemical Society or the Institute of Chemists. To do so would be a mere waste of energy, time, and resources. It must take up ground hitherto uncovered, the whole of such ground, and, if possible, nothing but such ground. This object will, we think, be best secured by acting on the opinions expressed by Dr. Schunck, Prof. Roscoe, Mr. Mond, and Dr. R. Angus Smith. The Society should embrace the whole field of manufacturing chemistry, and its objects would be most satisfactorily expressed by its adopting the name "Society of Technical Chemists." To the views of Mr. Eustace Carey, shared apparently by Dr. Hewitt, certain grave exceptions may be taken. The former of these gentlemen proposed that the Society should be called the "Society of Chemical Engineers." He further defined a "chemical engineer" as a "person who had mechanical knowledge, and who applied that knowledge to the utilisation of chemical action." But there are many ways in which the chemical arts may be promoted which do not in any way turn upon the application of mechanical knowledge. An invention may, and very generally does, turn upon the utilisation of some reaction hitherto unknown, or at least overlooked, and the person discovering such reaction may either have no mechanical knowledge at all, or if he has may not derive from it any assistance in the investigation which he has in hand. We do not deny that a Society of Chemical Engineers might exist, and might as such do work of great importance. But it would not cover the ground which is required, and would necessarily exclude many men engaged not in pure chemistry but in the chemical arts, and who are promoting manufactures by their chemical knowledge. On the other hand, the name proposed by Mr. Carey would, as Dr. Mond hinted, admit men who were not chemists at all. The great part of the work to be done, and of the problems to be solved in the future—as far as the chemical arts are concerned—cannot, in our opinion, be brought within the limits of the term "engineering" as understood in England. In France and Germany the word covers more or less distinctly the application of *any* science to industrial purposes.

We feel, therefore, very well satisfied with the resolution which was unanimously adopted:—"That a committee be appointed to consider the question of the formation of a society for the promotion of the application of chemical science to manufactures."

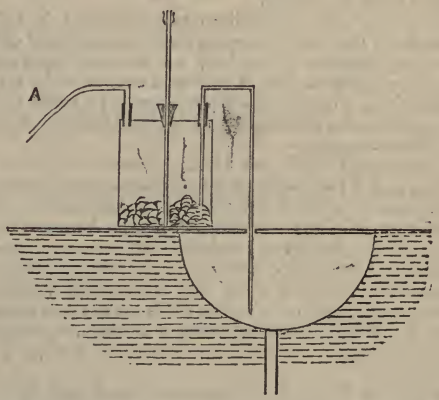
We shall await the report of this committee with much interest, and shall feel extremely gratified if they are able to draw out a definite plan for the organisation of such a society. Any assistance which we can render in so laudable an undertaking we shall be happy to furnish.

SULPHURETTED HYDROGEN APPARATUS.

By A. PERCY SMITH, F.C.S., F.I.C.

From time to time letters have appeared in the Chemical News describing various forms of apparatus for producing sulphuretted hydrogen, designed with the purpose of obtaining an automatic supply of the gas, or else as a more convenient method than the old original way. Having tried all these forms, and a good many others of my own designing, I have long since come to the conclusion that they are all failures, and that the only apparatus that is to be depended upon is the old bottle and thistle funnel.

Of all the forms of automatic apparatus perhaps Kipp's is the best, but I have found it almost impossible to prevent leakage of gas at the cork where the tap is inserted. This, of course, results in finding no sulphide left when you wish to use the gas. Added to this, the cold acid dissolves so slowly and so soon gets saturated with ferrous sulphate that I soon gave up the use of it in despair, and turned it into a hydrogen generator.



Apparatus consisting of two bottles connected with an india-rubber tube are not bad in idea, but in practice are failures, owing to the hardening of the tube and consequent leakage, also clogging, from deposition of ferrous sulphate. In fact, whatever form is used constant washing out is imperative, and when the apparatus is at all complicated in structure this becomes a nuisance; so that all appliances for saving the acid are really of no use. One of the forms that have been suggested consists of a lump of galena suspended in a bottle of acid, and forming one pole of a galvanic couple. On joining two wires outside the cork H_2S is evolved, but so slowly as to be practically useless, otherwise it is a good idea.

Fusion of sulphur and paraffin in a flask usually results in an explosion, caused by the stoppage of the evolution tube with sublimed sulphur, and the mixture spreads over the surface of the flask so as to totally exclude a sight of its contents; the gas, moreover, has a peculiarly offensive smell. We are therefore driven back to the old form, and

in order to render the washing out a simple matter, about two years ago I made an addition in the form of a syphon, which obviates the necessity of removing any of the tubes.

A three-necked Wolff's bottle has a funnel-tube in the centre hole, a syphon in one of the side holes, and the delivery-tube in the other. The gas is evolved by adding a freshly prepared mixture of H_2SO_4 and water (which is at about the temperature of boiling water). The evolution of gas under these circumstances is immediate and rapid, and when a sufficient gas is obtained, I pinch the rubber tube A, and pour more water down the funnel till the acid liquid begins to syphon off, and flows away through an aperture in the lid into the basin below (in the fume chamber). When the acid has gone, I follow up with more water, till the sulphide is properly washed. (It is as well to have the syphon capable of sliding in its cork, as if the interior end becomes covered with powder it may refuse to work until raised).

I have had this apparatus in constant work for two years, and during that time it has never been taken to pieces for cleaning. Fresh sulphide is dropped through the centre hole as required.

Rugby, May 10, 1880.

ON A BLACK SUBSTANCE PRODUCED FROM SULPHUR.*

By H. CHAPMAN JONES.

When sulphur is burned there is invariably a black residue left, which disappears if heated to a red heat. Every sample of sulphur, of whatever quality, that I have been able to obtain during the last few years has shown this reaction most distinctly.

During my work on sodium polysulphides (see *Journ. Chem. Soc.*) this substance has been occasionally obtained in very appreciable quantities; but so mixed with sulphur and other matters that it was in a totally unfit state for anything like a complete examination. In order to know how to deal with this body I have obtained the following facts concerning it:—

Concentrated HCl and HNO_3, concentrated or dilute H_2SO_4, may be evaporated away from a vessel containing it, apparently without affecting it in the least. Boiling solution of KCy has no action on it, nor fuming sulphuric acid after standing even for days. It does not appear to suffer any change on digesting it for three weeks in CS_2. If heated to just below a red heat it disappears, apparently burning away, but no characteristic odour has ever been detected. Fusing nitre dissolves it at once, at a temperature considerably below that necessary to get rid of it by mere heat.

To get an idea of the quantity produced by merely burning sulphur, I prepared some sulphur by acidifying with hydrochloric acid and boiling, a mixture of clear solutions of sodium thiosulphate and ammonium sulphide. The precipitated sulphur was boiled with dilute hydrochloric acid, then repeatedly with water, and dried at 100°. It was again treated with acid, and boiled a considerable number of times with water, and dried.

Portions of this sulphur were then burned in porcelain vessels, and the residue heated to a temperature that would ensure the absence of unchanged sulphur. The black substance was distinctly seen to separate from the melted mass as combustion proceeded.

Weight used.	Total Residue.	Loss on Ignition.
1 grm.	0·0005	0·0002
1 ,,	0·0004	0·0002
1·5 ,,	0·0008	0·0004
2 ,,	0·0012	

This last residue, or rather film, was scraped together, introduced into a small glass tube and heated. At a red heat a sublimate apparently of ordinary sulphur was formed, the residue being scarcely appreciable.

Having thus obtained sufficient information respecting this substance to know how to deal with it, I do not propose to investigate it further, as Dr. Theodor Cross (*Berl. Acad. Ber.*, 1879, p. 788) is examining certain products from sulphur, and among them most probably this one.

ANALYSES OF SOME AMERICAN TANTALATES.*

By W. J. COMSTOCK.

The following paper contains analyses of three American tantalates which have not been previously investigated, and which offer some points of especial interest.

No. I. was collected by the late Prof. F. H. Bradley, in Yancey county, N C.; its precise locality is unknown. The specimen analysed was from a massive piece, a few ounces in weight. Specific gravity = 6·88.

	I.	II.	Mean.	Ratios.	
Ta_2O_5 ..	60·50	59·35	59·92	0·1349	0·2231
Nb_2O_5 ..	23·02	24·24	23·63	0·0882	
FeO	12·90	12·82	12·86	0·1786	0·2302
MnO	3·09	3·03	3·06	0·0431	
MgO	0·35	0·32	0·34	0·0085	
Total	99·86	99·76	99·81		

$R_2O_5 : RO = 1 : 1·03$ and $Nb_2O_5 : Ta_2O_5 = 1 : 1·53$, or nearly 2 : 3.

No. II. was from Northfield, Mass. The portion analysed was a fragment of a large crystal, which had the habit and angles of ordinary columbite. It was placed in my hands by Prof. Brush. Specific gravity = 6·84.

	I.	II.	Mean.	Ratios.	
Ta_2O_5 ..	57·23	56·57	56·90	0·1281	0·2281
Nb_2O_5 ..	26·62	27·01	26·81	0·1000	
FeO	10·11	9·98	10·05	0·1397	0·2225
MnO	5·92	5·85	5·88	0·0828	
Total	99·88	99·41	99·64		

$R_2O_5 : RO = 1·025 : 1$ and $Nb_2O_5 : Ta_2O_5 = 4 : 5·1$.

No. III. was from Branchville, Conn. Its occurrence was described by Messrs. Brush and Dana,† and the specimen analysed was given to me by them. Only a small quantity of the mineral was found at the locality, and enough for one analysis was all that could be obtained pure. Its powder was brownish grey, and in thin fragments it was slightly translucent. Specific gravity = 6·59.

		Ratios.	
Ta_2O_5	52·29	0·1175	0·2301
Nb_2O_5	30·16	0·1126	
MnO	15·58	0·2194	0·2319
FeO	0·43	0·0059	
CaO	0·37	0·0066	
Total	98·83		

$R_2O_5 : RO = 1 : 1·007$ and $Nb_2O_5 : Ta_2O_5 = 1 : 1·04$.

Tantalic and niobic acids were separated by Marignac's method,‡ in the application of which I have received all necessary aid from Prof. O. D. Allen. In other respects the methods recommended by H. Rose were followed.

* Read before the Chemical Society, April 1, 1880. Communicated by the Author.

* Contributions from the Laboratory of the Sheffield Scientific School, No. lvii.

† *American Journal of Science*, July, 1878, p. 34. The specific gravity, by a typographical error, as I am informed, is there given 5·6 instead of 6·5.

‡ *Archives des Sci. Phys. et Nat.*, January, 1866.

The ordinary methods of testing for and separating tin, tungsten, and titanium were applied in each case, with negative results.

The relation between the specific gravities of columbites and tantalites and the percentage of tantalic acid, shown by Marignac, holds good in these examples also, as will be seen by a comparison with the numbers given in Marignac's table.*

		Sp. gr.	Ta_2O_5.
1.	Columbite, Greenland	5·36	3·3 p.c.
2.	,, Acworth, N.H.	5 65	15·8 ,,
3.	,, La Valate, near Limoges	5·70	13·8 ,,
4.	,, Bodenmais (*Dianite*)	5·74	13·4 ,,
5.	,, Haddam, Conn.,	5·85	10·(?) ,,
6.	,, Bodenmais	5·92	27·1 ,,
7.	,, Haddam	6·05	30·4 ,,
8.	,, Bodenmais	6·06	35·4 ,,
9.	,, Haddam	6·13	31·5 ,,
10.	Tantalite	7·03	65·6 ,,

To which are here added—

Yancey Co., N.C.	6·88	59·92	,,
Northfield, Mass.	6·84	56 90	,,
Branchville, Conn.	6·59	52·29	,,

These all agree with the formula $(Fe,Mn)(Ta,Nb)_2O_6$.

Since tantalum and niobium appear capable of replacing each other in all proportions in columbites and tantalites, Rammelsberg† has suggested that when the number of tantalum atoms exceeds that of the niobium atoms, the mineral should be called tantalite, and when the number of niobium atoms exceeds that of the tantalum, the mineral should be called columbite (Rammelsberg uses *niobite*). According to this method of classification, the Yancey county and Northfield minerals would be called tantalite, although the latter in form is not to be distinguished from columbite. The manganese niobo-tantalate from Branchville, however, has the ratio Nb : Ta = 1 : 1 (very nearly), a coincidence which we might reasonably have supposed possible. The almost complete displacement of iron by manganese is also an interesting peculiarity of the Branchville mineral, and is doubtless the cause of its slight translucency and the light colour of its powder.

It is perhaps of interest to add here that a mineral of this group from Utö, Sweden, containing 85·5 per cent of tantalic and niobic acids and 9·5 per cent of manganese protoxide (3·6 FeO), has been called *mangantantalite* by Nordenskiöld.‡

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, May 20, 1880.

Prof. H. E. Roscoe, President, in the Chair.

The following certificates were read for the first time:—P. S. Brown, E. Moritz, and F. E. Matthews. It was announced that the Longstaff Medal had been awarded to Dr T. E. Thorpe, of Leeds. The presentation will probably take place in October.

The President then called on Dr. Frankland to read a paper "*On the Action of Air upon Peaty Water*," by Miss Lucy Halcrow and E. Frankland. Dr. Tidy, in his paper on "River-Water" (*Chem. Soc. Journ.*, 1880, 295), contends that the peaty matter in running water is rapidly oxidised. He instances the water of the Shannon, which he alleges loses thus more than 38 per cent of its organic matter during a flow of one mile, and the water supply of a town in the north of England, which similarly loses 50 per cent of its organic carbon during a flow of less than 4 miles through an open brickwork conduit. If peaty matter in solution in water possesses this extraordinary affinity for oxygen at ordinary temperatures it cannot be necessary to appeal for proofs of it to large bodies of water, which are always more or less liable to alterations from other causes. The authors have therefore studied upon an experimental scale the action of exceptionally strong peaty water upon atmospheric air, so as to ascertain how far air loses oxygen by contact with such water, and have submitted to eudiometrical analysis limited volumes of atmospheric air, which had been exposed for various periods to the action of large volumes of peaty water from unpolluted mountain sources. A sample of peaty water freely exposed in a stratum of 5 inches deep to the action of sunlight and air without shaking in a glass bottle for 70 days, lost only 6 per cent of its organic elements, at the same time depositing a slight brownish sediment. Four experiments are given as to composition of the air which had for some time been in contact without shaking with peaty water. The following will serve as an example:—Original water contained 0·0399 part of organic carbon, and 0·074 N per 100,000. After a year it contained—0·0354 C and 0·069 N. The air which had been in contact with the water contained—CO_2, 0·10; O, 20·76; N, 79·14. The results prove that the extent to which the peaty matter of the upland water was oxidised in periods of more than a year was very small indeed, as the carbon alone would have been sufficient to have taken up the whole of the oxygen from 100 c.c. of air. Experiments are next quoted in which the peaty water was violently agitated with air in accurately stoppered bottles of about 500 c.c. capacity, half filled with the sample under examination. The water before use contained in 100 volumes, 2·01 vols. of air, having the composition 1·99 per cent CO_2, 31·96 per cent O, 66·05 per cent N, and was therefore well aërated. Four experiments are then given, in which the water was well shaken with the enclosed air; in one case on the connecting rod of a steam-engine making 100 strokes per minute for ten and a half hours, at temperatures from 18° to 30°. In no sample was the colour materially altered, and the composition of the enclosed air remained almost unaffected. Thus the air in the bottle which had been attached to the steam-engine contained—0·12 per cent CO_2, 20·75 per cent O, 79·13 per cent N. Analyses were also made of air which had been shaken up with the Kent Company's water, the Colne Valley Company's water, and pure distilled water respectively. An analysis of the atmospheric air used gave—CO_2, 0·12 per cent; O, 20·94 per cent; N, 78·94 per cent. The volume of air contained in each bottle was 234·5 c.c., and from this the organic carbon alone in the water (0·00728 grm.) would remove during complete oxidation 0·0194 grm. or 13·5 c.c. of oxygen, leaving the residual air with only 15·1 per cent of oxygen. If we compare the percentage amounts of oxygen found in the different samples of air which had been in contact with peaty water with those found in the air which had been similarly shaken up in the Kent and Colne Valley Companies' waters and in the organically pure distilled water, and lastly with the percentage of oxygen in the air of the room in which the experiments were made, it is evident that minute quantities of oxygen have been absorbed by nearly all the peaty waters, but even in an extreme case in which the water travelled more than 20 miles on the connecting rod of a steam-engine, the amount of oxygen absorbed by 250 c.c. of extremely peaty water was only 0·345 c.c., which is scarcely 1-39th of that required for the complete oxidation of the organic carbon alone, or in other words, only 2½ per cent of the organic matter was oxidised, assuming that all the oxygen taken up was employed in the oxidation of organic matter; and deducting from this percentage the amount of oxygen absorbed by the Kent and Colne Valley

* Given in his paper first referred to, in which he explains the variations from a regular progression, which are seen in the table.

† *Mineral Chemie*, 2nd edition, 1875, p. 356.

‡ *Zeitsch. Kryst.*, i., p. 386, 1877.

Companies waters, we have only 1·6 per cent of the total organic matter in the peaty water oxidised in the steam-engine experiment. The authors therefore conclude that if peaty matter dissolved in river water is spontaneously oxidised (of which there is as yet no sufficient proof), the process takes place with extreme slowness, and cannot be accomplished to any considerable extent in the flow of a river. During the experiments a considerable precipitation of brown peaty matter was observed when the strong bog drainage was mixed with a small bulk of distilled water. The cause of this precipitation the authors intend to investigate.

The President in proposing a vote of thanks to Dr. Frankland and Miss Lucy Halcrow (who was present at the meeting), said it would perhaps be advisable not to take the discussion on this paper until Dr. Frankland had read a further communication.

Dr. Frankland, in acknowledging the vote of thanks, said that the work in the paper was almost entirely carried out by Miss Halcrow.

The President then said that the Discussion on Prof. Tidy's paper would now take place. He suggested that it would be well to limit the discussion to the point of "The Oxidation of Organic Matter in Rivers." He then briefly mentioned the chief statements in Prof. Tidy's paper, on which he based his assertion that organic matter is rapidly oxidised in running water, and called on Dr. Frankland to open the discussion.

Dr. Frankland said that he must apologise to Prof. Tidy for confining himself on that evening to the question of oxidation. There were many portions of the paper in which he cordially agreed with Prof. Tidy, and his researches on the water of the River Nile and on Filtration were of the highest value. He should, however, consider only the question of oxidation. Can running water be at all times safely used for dietetic purposes a few hours or days after it has been mixed with sewage? This is a question of very vital importance to many millions of people in this country. Twelve years ago there was a general impression amongst chemists and others that polluted water quickly regained its original purity by spontaneous oxidation. This opinion had no foundation in quantitative observations; indeed there was not a single experimental fact to support it, for the previous condition of water analysis did not permit of the quantitative investigation of organic matter dissolved in water. Two classes of persons strongly interested in its acceptance were chiefly instrumental in the origination and diffusion of this opinion. These were the polluters of river-water and water companies drawing their supplies below the sewer outfalls of towns. Both these influential classes have always contended that even the most abominable of organic rubbish is destroyed by oxidation, in fact utterly burnt up during a flow of a few miles. This was a comfortable doctrine, and therefore a popular one. Nevertheless, it did not pass entirely unchallenged; indeed, it is difficult to imagine how any chemist accustomed to the habits of organic compounds could accept such an opinion without proofs. In 1865, Prof. Brodie entered his protest against the popular doctrine. The first Rivers Pollution Commissioners, R. Rawlinson, J. T. Harrison, and Prof. Way, concluded "that as a water supply the Thames, polluted with the sewage of the inhabitants of the river basin, is open in kind, if not in degree, to the same objections as well-water infiltrated by liquid from an adjoining cesspool. Well-water so tainted may appear to sight, taste, and smell to be harmless, and has been known to be drunk for a length of time without apparent mischief, but beyond all doubt that same water is liable under particular conditions to become poisonous." The prevailing opinion was, however, in favour of the rapid oxidation of organic matter in running water, when the Second Rivers Pollution Commissioners of 1868 undertook the quantitative investigation of the subject. During six years they determined the rate of oxidation, first, during the flow of intensely and moderately polluted rivers, secondly in artificial mixtures of sewage and water by prolonged agitation with air, and thirdly by observing the diminution of dissolved oxygen in a mixture of sewage and water excluded from the air. For the determination of the rate of oxidation in strongly polluted water, the rivers Mersey, Irwell, and Darwen were selected as streams offering favourable conditions for quantitative experiments, because, after being intensely polluted, each of them flows for several miles without encountering any further material pollution, and their waters are well mixed by weirs, &c. The speaker then detailed the analyses, which unmistakeably disclose the fact that a flow of between 11 and 13 miles at a temperature of 18° C. produces but little effect upon the organic matter dissolved in the water, and that at or below 13° C. oxidation is practically arrested, although in the case of the Irwell the water was most effectively aërated by falling over six weirs. The results may be summarised thus:—

					Percentage Reduction of Organic Elements.
Irwell, after a flow of	11 miles	at	6·5° C.	..	1·7
,,	,,	,,	12·7	..	0·0
,,	,,	,,	17·8	..	26·5
Mersey	,,	13 miles	at 4·5	..	20·5*
Darwen	,,	,,	8·7	..	0·0

* No correction for unpolluted affluents.

The rate of oxidation in a river less polluted, in which animal and vegetable life still flourished:—For this purpose the Thames between Reading and Shiplake Paper Mill was chosen. Every care was taken to ensure fair and strictly comparable samples. Some difficulty was experienced in effecting this, owing to the great distance necessary to ensure a complete mixture between the waters of a main stream and those of a tributary. Thus the Kennet, after joining the Thames, flows nearly two miles before its individual character ceases to be apparent, and it is only after the passage of the weir and rapids at Sonning Bridge that a thorough mixture takes place. The samples were taken on a bright sunny day at the end of May, and therefore under circumstances very favourable to oxidation, but the reduction in the proportion of organic matter was exceedingly small, only 5·7 per cent at 16·7° C.; so that allowing for the retardation of the process by night, &c., it would be incorrect to assume that the river would clear itself of organic matter by a flow of 70 miles. These results were checked by experiments with artificial mixtures of sewage and water. The mixture was violently agitated every day, and was daily syphoned off and allowed to fall slowly about 3 feet, at a temperature of about 20° C. In 96 hours the organic carbon was thus reduced 6·4 per cent, and the organic nitrogen by 28·4 per cent: after 192 hours the reduction was 25·1 per cent carbon and 33·3 per cent nitrogen. This shaking, &c., was supposed to be equivalent to a flow of 96 and 192 miles respectively at a rate of one mile an hour. Similar experiments with a mixture of urine and water gave similar results. By studying the rate at which atmospheric oxygen disappears when dissolved in polluted water it was again proved that oxidation takes place very slowly, the results being that in the first period of 24 hours 6·8 per cent of the sewage was destroyed; in the second period of 24 hours, 8·9 per cent; in the third period of 48 hours 14·3 per cent; in the fourth period of 24 hours, 5·4 per cent; in the fifth, 5·8 per cent; in the sixth, 2·1; making altogether 43·3 per cent. That even this oxygen was not all used up in oxidising the carbon was proved by the fact that the quantity of carbonic acid present remained constant. The Rivers' Commission therefore concluded from the experiments made upon rivers and artificial mixtures of sewage and pure water that the oxidation of the organic matter in sewage proceeds with extreme slowness, and that no river in the United Kingdom is long enough to effect the destruction of sewage by oxidation. For six years these results have never been called in question. Dr. Tidy, however, whilst conceding the accuracy of the experiments, objects to the

conclusions, and from his own experiments concludes that peaty matter is rapidly, and sewage matter still more rapidly, oxidised in running water, and states that in his opinion the oxidation of the organic matter in sewage matter proceeds with extreme rapidity, and that after a run of a few miles, if the dilution be sufficient, the removal of the whole of the organic impurity will be effected. This conclusion is founded upon the results of analyses of samples of water taken from the Severn, the Shannon, and from certain conduits in the North of England, and also upon experiments made with sewage matter flowing through glass-lined troughs. A careful examination, however, of the conditions under which the samples were taken and the experiments made proves that they are in most cases consistent with the results obtained by the author of the present paper, while none affords any trustworthy basis for the conclusions arrived at by Dr. Tidy. As regards the Severn, the analyses, if they prove anything, prove too much. Thus, comparing sample No. 2 with sample No. 3, it appears that a flow of 30 yards has reduced the organic elements by 32 per cent; the river should therefore be quite pure after flowing 100 yards. The next mile only produced a diminution of 12 per cent more. This discrepancy is doubtless due to a want of care in taking the samples, and is caused by the varying admixture of the pure water from the affluent, the Teme, with the polluted water of the Severn. This is, indeed proved by the chlorine determinations, which show for the first 30 yards flow a diminution of 41 per cent, whilst during the next mile only another 11·4 per cent, and proceeding, therefore, *pari passu* with the diminution of organic matter. Prof. Tidy suggests that the rapid decrease of the chlorine in 30 yards is caused by its absorption by vegetation, but produces no proof of such a powerful, and at the same time irregular, absorption. The River Wear is next considered. It is stated that between Bishop Auckland and Durham, a flow of 13 miles, the whole of the sewage of the former town is oxidised, and indeed the river is purer than it was above Bishop Auckland; even the nitrates themselves appear to be oxidised. The Rivers' Commissioners testify that the Wear at Durham is a "good water." The fact has been apparently completely overlooked by Prof. Tidy that during this 13 miles flow a considerable tributary of highly ferruginous water enters the Wear, the potency of iron in removing various organic matters from water being well known, and referred to by the Rivers' Commissioners. It is therefore probably to this ferruginous tributary and to the influx of a larger affluent, the Brownie, that this diminution of organic matter is due, at all events no one can allege that the cleansing is due solely to oxidation. As regards the alleged statement of the Rivers' Commissioners, they really said that the water was good *considering its source*, having previously described the impurity of the latter. As to the evidence drawn from the composition of Thames water at Lechlade and Hampton, the only evidence on the subject is furnished by two samples taken at Lechlade on April 18, 1868, and at Hampton on May 4, 1868, the former containing 0·133 and 0·033 of organic carbon and nitrogen, the latter 0·260 and 0·024. At Lechlade the river was running 100,000,000 gallons daily; at Hampton, 554,000,000; a flood had also occurred on April 21—24. But granting that the Thames at Hampton contains no more organic matter than at Lechlade, it by no means follows that the sewage of a million people had been got rid of, for (1) the volume has been augmented more than fivefold, to some extent by pure spring water; (2) a considerable proportion of the sewage drains into cesspools, &c., and only enters the Thames after a flood; (3) when the Wey mixes with the Thames about 6 miles above Hampton, the mixtures becomes turbid, and a precipitation of organic matter takes place; (4) for several miles above Hampton the Thames runs through a vast deposit of flint, gravel, and sand, which sops up its water like a sponge and restoring it again at a lower level, and thus vast volumes are exhaustively filtered through gravel and sand, and the organic matter is consequently oxidised in a porous medium—a most potent agency in nature for the removal of organic matter. As regards the Shannon, Prof. Tidy's observations were limited to a portion of 37 miles, 23 in Loch Derg, and 14 in the river. It was found that in flowing through Loch Derg the organic elements diminished from 1·02 to 0·84 per cent, *i.e.*, about 18 per cent. The next sample, taken a mile lower down, shows a diminution of more than 38 per cent. The next sample, 4 miles lower down, shows an increase of 75 per cent. Four miles lower, at the foot of the Castle Connell Falls, a further sample was taken: it showed a diminution of 28 per cent. The last sample was taken above the junction of the River Mulkear, and here the organic elements had again increased 53 per cent. Thus, from the analyses, a run of a mile having a surface of less than one-tenth of a square mile reduces by oxidation the organic elements 38 per cent, whilst the passage through Loch Derg of 23 miles, exposing a surface of over 50 square miles plus 2 miles of river, diminishes them by only 18 per cent. After leaving the oxidising section the river flows 4 miles, and arrives at O'Brien's Bridge, and has gained 75 per cent of peaty matter. To account for this increase by an influx even of black peaty water requires an augmentation of the river one-third of its total volume. This increase is quite incredible, and the author concludes that somehow or other the samples taken did not fairly represent the main body of the river, and that the conclusions drawn by Prof. Tidy are therefore quite unwarranted. The analyses of the peaty water flowing through an open and a closed conduit, quoted by Prof. Tidy, are probably in a similar way rendered fallacious owing to the probable introduction *en route* of spring-water into the open conduit. The mysterious influence which so favours the oxidation of polluted water running in rivers with numerous unpolluted affluents appears to be always absent when the water is put under conditions admitting of the application of accurate experimental tests. Prof. Tidy therefore constructed a series of V-shaped troughs lined with glass, altogether 200 feet long. By means of this apparatus he finally demonstrated the oxidation of sewage in water. To these experiments the author objects—(1) That the water was exposed to an enormously greater solid surface than in any river. (2) It is not stated that the sewage was filtered, and loss might occur by deposition on the troughs. (3) And chiefly, after a short time the urea in sewage would be transformed into ammonic carbonate. While there is no evidence whatever of the destruction by oxidation of the dead organic matter by a flow of a dozen miles, still less is there any ground for assuming that the organised and living matter of sewage is destroyed under like circumstances. Bacteria develop, multiply, and flourish for weeks in attenuated liquids. Here the author read a letter from Prof. Tyndall, in which, after apologising for his compulsory absence, he designates Prof. Tidy's views on germs as very plausible, but utterly chimerical, and continues—"Well, what about the germs of bacteria, do they commit suicide by endosmic action? So far is this from being the case, that Dr. Tidy cannot take a single drop of water from his tap that does not contain living germs capable, when placed in a proper nutritive fluid, of developing themselves into countless multitudes of bacteria. Pray ask Dr. Tidy what reason has he to suppose that other germs behave differently from those of *Bacteria termo*." The author then criticises the assumption that the epithelial scales from scarlet fever patients, &c., are daily oxidised and disappear, and challenges Prof. Tidy to prove by a delicate balance any marked diminution of weight in any such mass of organic *débris* from oxidation. The author then upholds and justifies his statement as to the immunity which would be conferred on the Metropolis from *epidemics* of cholera if it had a supply of pure water, by reference to statistics from Bethlehem Hospital, Millbank Prison, &c. In conclusion the author agrees with Professor Tidy when he says, of water supplied to a community, "Art may be fairly asked to improve a good water, but it is simply

madness to ask her to deal with bad water." And again, "That impure water has been one of the most active causes of disease is a fact which to my mind has been proved beyond doubt. The researches of Dr. Ballard on typhoid, &c., supply evidence that should make us very jealous indeed of allowing a water to be used for drinking over which hangs the merest shadow of a suspicion. No one can be too strictly a water purist." The question, therefore, Can running water be at all times safely used for dietetic purposes a few hours or days after it has been mixed with sewage? is answered by the author in the negative.

The President said that all must compliment Dr. Frankland on the complete, clear, and withal, good natured criticism, to which they had listened with so much interest. He would ask Prof. Huxley to say something on the subject of bacteria.

Prof. Huxley did not wish to take part in the chemical controversy, but it had struck him on reading over Dr. Tidy's paper that there was a good deal of what he might venture to call "biological turbidity" in it. To this turbidity he would, as far as was in his power, act as a filter. He would state briefly only what were demonstrable facts. Diseases caused by what people, not wisely, call germs, *e.g.*, splenic fever, pig-typhoid, &c., are caused invariably by bodies of the nature of bacteria; they could be cultivated through twenty to thirty generations, and then when given to the ox or the pig would invariably give rise to the characteristic disease. We have no reason even to imagine that any body capable of causing disease by such means could be anything but a body having the nature of a bacterium. Now bacteria are just as much plants as mushrooms or cabbages or the *Wellingtonia gigantea*, so that we know under what conditions bacteria can live and what they will do. Bacteria can be sown in Pasteur's solution just as mustard and cress can be sown in the soil; in it they thrive, and the liquid becomes milky, and he would ask the President whether there was any known method by which if one drop of this Pasteur's solution were placed in a gallon of water its constituents could be estimated. (The President having answered that he thought it was doubtful, the speaker continued)—Every cubic inch of such water would contain 50,000 to 100,000 bacteria, and one drop of it would be capable of exciting a putrefactive fermentation in any substance capable of undergoing that fermentation. For purposes of public health, the human body may be considered as such a substance, and we may conceive of a water containing such organisms, which may be as pure as can be as regards chemical analysis, and yet be as regards the human body as deadly as prussic acid. I am aware that chemists may consider this as a terrible conclusion, but it is true, and if the public are guided by percentages alone, they may often be led astray. The real value of a determination of the quantity of organic impurity in a water is, that by it a very shrewd notion can be obtained as to what has had access to that water. If it be proved that sewage has been mixed with it, there is a very great chance that the excreta of some diseased person may be there also. On the other hand, water may be chemically gross and yet do no harm to any one. The whole source of damage being, in the belief of the speaker, in the disease germs. As to the bursting of the envelopes by endosmosis, it was a question whether they had any: bacteria would be large if 1-20,000th of an inch in diameter; moreover, ordinary water was full of them, and in it they could be shaken for an indefinite period without harm. As long as bacteria had nutrition, there was no reason to suppose that oxidation or endosmosis would affect them. If, however, they were deprived of nourishment and exposed to sunlight the case might be very different.

The Secretary then read a few remarks which had been sent by Dr. Mills. Dr. Mills has calculated the ratio of—

$$\frac{\text{Oxygen consumed}}{\text{Sum of organic C+N}}$$

and finds that it is not constant but varies in different streams. He does not think it possible to determine the peat in a water by its tint depth, owing to the difference of colour. River water commonly contains a slimy or pectinous material which tends to separate out on any substance which acts as a nucleus. This has, in the author's opinion, a most potent influence on the purification of river water. The oxygen theory of the natural purification of waters seems utterly untenable. The criticisms of the author coincide in several respects with those already advanced above by Dr. Frankland. In conclusion the author expresses his admiration of the patience with which Dr. Tidy has collected his facts, and of the meritorious accuracy of his analytical results.

Prof. Bischof called attention to the omission of the cholera years in the statistics given by Prof. Tidy.

Prof. Tidy, in his reply, relied mainly on the powerful testimony given in his behalf by the statistics of the last ten years. Notwithstanding the possible contamination of a large bulk of river water by a minute drop of a fluid containing germs, yet there were as many cases of fever in towns supplied solely by well water as in those supplied by river water; this holds good for towns all over England as well as in different districts of the same town. He took exception to the laboratory experiments of Dr. Frankland on oxidation; they were doubtless most interesting and satisfactory experiments as regards shaking fluids up in bottles, but they did not represent the flow of a river, there was no vegetation, no animal life. As regards the diminution of sodium chloride in the Severn, he contended that plants did cause a decrease in the quantity of sodium chloride in running water. As to the Shannon, he knew every inch of it, and perfect streams of black drainage entered into Lock Derg and elsewhere quite sufficient to account for the discrepancies noted by Dr. Frankland. He collected the samples of water himself, and did his utmost to collect them fairly. He had no interest whatever in commending any water. In conclusion, Prof. Tidy said, that although his paper might be considered in some respects an attack on Dr. Frankland, he wished to thank him for the freedom and the kind way in which he had met him at every turn, and expressed a hope that Dr. Frankland would join him in fighting the prevailing heresies on this question which tended so to upset the public mind.

Dr. Frankland having declined, owing to the late hour, the right of reply, the meeting, which had been crowded all the evening, separated shortly after eleven, and the Society adjourned to June 3.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, March 9, 1880.

J. P. Joule, D.C.L., LL.D., F.R.S., &c., President, in the Chair.

"*Analyses of the Ash of Wood of Two Varieties of the 'Eucalyptus' Tree*," by Watson Smith, F.C.S., F.I.C., Demonstrator and Assistant Lecturer in the Owens College.

During Easter, 1877, Mr. James Young, LL.D., F.R.S., suggested to me that I should make analyses of the ash of the two varieties of eucalyptus, viz., *E. rostrata* and *E. globulus*, commonly known as red and blue gum trees. The pieces of wood I was supplied with by Dr. Young. They appeared to be stout branches, "crop-wood," and had the bark still on. The wood of *E. rostrata* ("red gum") was evidently closer and denser in texture than that of the "blue gum," or *E. globulus*. Its bark was also thinner and smoother. I took the samples of the wood to a joiner in Zürich, and requested him to plane them down to thin shavings, with the exception of a

transverse section of each variety, to be reserved for specific gravity determinations. I requested him also to notice any peculiarities he might notice in the wood and report them, with his opinion of their quality. On calling subsequently, I noticed on entering the shop the odour of the gum or essential oil peculiar to the tree. The whole shop was fragrant with it. On planing the wood to shavings this odour is quickly diffused around. The joiner stated it as his opinion that the wood of the "red gum" variety especially was extremely hard. It had quite turned the edge of his plane. The timber of such a tree, he said, would be of great value. The wood of the "blue gum" tree was a little behind in point of hardness and solidity. Determinations were now made of the *specific gravity* of these woods in what may be termed the *air-dried* condition. The sections of both varieties had been placed in a dry atmosphere for one month. The results were :—

Eucalyptus rostrata, "Red gum."		*Eucalyptus globulus*. "Blue gum."	
Specific gravity..	0·8112	Specific gravity..	0·772

These sections were now planed (bark included) to thin shavings, which were now weighed, burnt in a platinum dish to white ash, and this was weighed. The results were :—

E. rostrata.		*E. globulus.*	
Ash	2·25 p.c.	Ash	2·01 p.c.

Analyses were now made of the ash obtained by burning the shavings of the larger samples. This ash was white, inclining to straw colour :—

Eucalyptus rostrata, "Red gum."		*Eucalyptus globulus*, "Blue gum."	
K_2O	9·50	K_2O	25·00
Na_2O	3·40	Na_2O	
MgO	6·30	MgO	6·47
CaO	43·80	CaO	35·08
Ferric and aluminic phosphates ..	0·78	Ferric and aluminic phosphates ..	1·07
MnO	trace	MnO	trace
SiO_2	0·29	Al_2O_3	trace
SO_3	1·57	SiO_2	0·34
Cl..	0·60	SO_3	1·55
Sand and carbon	1·77	Cl..	0·85
		Sand and carbon	1·04

The leaves of the eucalyptus contain very considerable quantities of tannin; in fact, I think it is certain at some time or other they may prove a valuable source of tannin if the tree be largely cultivated. I have been told that in some parts where the tree abounds a kind of decoction is made of the leaves, and drunk as tea is.

NOTICES OF BOOKS.

Alphabetical Manual of Blowpipe Analysis, showing all known Methods, Old and New. By W. A. Ross, Lieut-Colonel, late R.A., Member of the German Chemical Society (Author of "Pyrology or Fire-Chemistry"). London: Trübner and Co.

The blowpipe, however justly appreciated in Germany and in America, finds little favour in England. We can scarcely name a chemist of any grade who is either engaged in researches requiring its application or who is seeking to extend its capabilities and verify its indications. A few brief and somewhat perfunctory notices of its use in qualitative mineral analysis do indeed figure in the innumerable chemical manuals and handbooks which are year by year showered upon us, but the present volume and its predecessor, "Pyrology," are, we believe, the only original and independent contributions to blowpipe chemistry which England has produced for at least half a century. The instrument, or to speak more correctly, the whole region of chemistry of which it serves as the symbol, is scouted alike by college graduates and amateurs, our scientific chemists and our examinees.

Colonel Ross, therefore, has a strong claim upon our attention and respect for keeping the blowpipe and its utility before the notice of the scientific public. Nor can it be denied that in this his peculiar department he has done sound and valuable work which is more appreciated elsewhere than at home. If he is mistaken in certain points surely experimental investigation would be a more legitimate way of meeting, and if needful refuting, his statements than what has been happily called "the conspiracy of silence."

The only perfectly satisfactory method of criticising the little book before us, *i.e.*, to go through all the reactions here described, in as far at least as they differ from what we find laid down in Plattner and earlier authorities, unfortunately requires more time than we have at our disposal. As far as we can fairly judge without such a practical survey, the methods here given are in general likely to prove of great value.

There are some passages, however, with which we are puzzled, and which we think, pending further evidence, might better have been omitted. Thus on p. 41 we read :—

"Chemical Water.—A combustible but not vaporisible compound, composed apparently of hydrogen and oxygen; present in every natural and in almost every artificially prepared oxide. It ignites at apparently red heat, and burns with an orange pyrochrome." Water which is combustible and not volatile at high temperatures is a paradoxical body, and we naturally wish to know whether it has been isolated and analysed?

On p. 51 we find a process for making artificial diamonds which certainly do not consist of carbon, and whose title to the name is therefore very questionable. The process is :—"Heat a fragment of caustic lime of a size proportioned to that of the stone required in the oxidising flame at the bottom of a bead of pure boric acid. A colourless and highly refractive ball is formed inside the bead, from which it is extracted by boiling water, the bead being very soluble, but the ball insoluble. The ball should be repurified in a fresh boric acid bead, and more caustic lime added until it is the required size, and can be then again extracted by boiling water. . . . . It is a curious coincidence with regard to these lime borate balls that they are, though perfectly spherical while within the bead, often extracted from that with a curved edge, formed by the meeting of two contiguous facets, like the natural form of many diamonds." We do not think that the author means to assert the identity of calcium borate with crystalline carbon, but we fear that this passage will be misunderstood or misrepresented.

Some question may also arise concerning the following "rough way of detecting alumina," namely, by holding a pea-fragment supported on a platinum hook in the flame of a spirit-lamp, or of a good blue candle reducing flame, when alumina and silica blacken, while lime and the alkaline earths remain white." Is this reaction peculiar to alumina and silica, or does it extend to all the earths? Is not the blackening due to a deposit of carbon, and if so may it not be produced on other bodies, according to the manner they are heated?

No experimentalist seems to have taken in hand to decide a question which Colonel Ross raised some years ago in the Chemical News, vol. xxxvi., p. 214. In Profs. Roscoe and Schorlemmer's work on Chemistry it is stated that :—"Most metallic oxides dissolve in boron trioxide at a red heat, many of them imparting to the mass characteristic colours; hence this substance is much used in blowpipe analysis." On the contrary, Colonel Ross asserts that most metallic oxides do *not* dissolve in boric acid before the blowpipe, do *not* impart colours to it, and finally that it is not much used in blowpipe analysis except upon his system. Referring to Plattner's work (Cookesley's

edition, p. 45) we certainly find nothing to confirm the assertion that it is much used. According to this authority:—"It serves in qualitative examination to detect phosphoric acid in minerals and a small quantity of copper in presence of much lead."

We see no reason to retract or modify the opinion which we expressed when noticing the author's "Pyrology," that to go through the methods here laid down and carefully note the results would be a most useful and suggestive course of study.

The Chemistry of Agriculture. By R. W. Emerson Maclvor. Melbourne: Stillwell and Co.

This work is a treatise on agricultural chemistry, with especial reference to the local circumstances of Victoria, and contains a very large amount of useful information clothed in very plain language. After some introductory explanations the author treats successively on the constituents of plants, on the growth of crops, on the formation and the chemical and physical properties of soils, on draining and tillage operations, on the exhaustion of land, on farm-yard manure and composts, on bones and superphosphates, on guano, saline manures, neglected fertilisers, the use of lime in agriculture, and on the rotation of crops.

We notice that bone-dust as sold in Australia differs considerably from English samples: it contains more organic matter, but less nitrogen, less phosphate, and sand reaching up to 14 per cent. It appears that the Australian farmers are too much given to the use of undissolved phosphates. We regret that, as far as can be judged by this work, no extensive deposits of mineral phosphate of lime have been found in Australia. The phosphatic guanos of Lacepede Island and Flat Island are used to a considerable extent both by farmers and manure-makers. Bat-guanos of fair value have been found in a number of caves. Blood and other animal refuse, capable of yielding manures no way inferior to Peruvian guano, is wasted to a very serious extent.

One of the most interesting portions of the book is the admirable Appendix by Baron von Müller, on the maintenance, creation, and enrichment of forests. The learned author shows most conclusively the importance of forests both in a sanitary and a climatic point of view. For covering the Australian deserts he particularly recommends the fig-tree, alike from its rapid growth, its adaptation to the climate, and its fruit.

The chief defect of the work is, in our opinion, the lack of an index.

CORRESPONDENCE.

SULPHUR IN PYRITES.

To the Editor of the Chemical News.

Sir,—The existence of sulphur in coal in combinations other than FeS_2 has been recognised long before the date mentioned by F.I.C., in his note on Dr. Wallace's paper. (Chemical News, vol. xli., p. 230.) Dr. Percy, in the first volume of his "Metallurgy," published in 1861, says of the sulphur in a certain coal that it "was present in the same state of combination in the coal as it exists in albumen, fibrine, &c." (*Vide* p. 102.) In the same work are numerous instances of coals containing a higher percentage of sulphur than of ash.—I am, &c.,

Henry Louis.

BLOWPIPE ANALYSIS.

To the Editor of the Chemical News.

Sir,—In April last I wrote you a letter, in which I alluded, among other things, to what Colonel Ross calls "ellychnine pyrochrome." I had not at that time been able to produce it, but being in London the other day, Colonel Ross was kind enough to show me the way. I can now get it readily, and it seems to me better, because more unmistakeable, than the flame colouration produced in the ordinary manner. Here I ought properly to add my own receipt for producing E.P., but I do not propose to do so, as I own I cannot improve on Colonel Ross's instructions already given, and, as I am sure your readers will know, ten minutes instructions in a laboratory is worth many pages of directions how to do it.—I am, &c.,

Triton.

THE ESTIMATION OF CARBON IN STEEL.

To the Editor of the Chemical News.

Sir,—In reply to Mr. G. E. Davis (Chemical News vol. xli., p. 229), if steel contained iron and carbon only, no doubt the weight of Fe_2O_3 produced would be a valuable check on the completeness of the combustion, but considerable percentages of other substances may be present. Several times statements have been made in the Chemical News and elsewhere impugning the accuracy of the colour test for the estimation of carbon in steel: my object in writing the note referred to by Mr. Davis was to show that when carefully worked very accurate results may be obtained.—I am, &c.,

James W. Westmoreland.

Bowling Iron and Steel Works,
May 24, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 16, April 19, 1880

Reciprocal Displacements of the Halogens.—M. Berthelot.—The author concludes that the inverse substitution of bromine for chlorine and of iodine for bromine is, *a priori*, possible in cases where the heat liberated by the formation of the secondary compounds exceeds the heat absorbed by direct substitution, and takes place in proportions regulated by the degree of dissociation of the secondary compounds. This substitution becomes likewise possible if the temperature is raised to the degree at which metallic chlorides, bromides, and iodides are dissociated, because then the halogen acts in reality upon a portion of the free metal. This substitution does not take place between potassium chloride and bromine, nor between potassium bromide and iodine, if heated to about 400°, at least if the accessory influences of air, moisture, and the materials of the glass are avoided.

The Stability of Oxygenated Water.—M. Berthelot.—The decomposition during the first month takes place in proportion to time, but afterwards the reaction slackens and is not complete at the end of two years. Finally, however, all the oxygenated water disappears. Dilution decidedly retards decomposition. The change is greatly modified by the presence of foreign matter. A specimen containing a trace of hydrochloric acid and of barium chloride was decomposed five times less rapidly than a specimen of the same strength free from these additions. The smallest trace of a soluble alkali, or of precipitated base, determines rapid decomposition.

The Earths of Samarskite.—C. Marignac.—The author divides the earths into four portions: (1.) Earths soluble in less than 100 parts potassium sulphate and having equivalents below 119. (2.) Earths soluble in

100 to 200 vols. potassium sulphate, and whose equivalent lies between 119 and 120. (3.) Earths very slightly soluble in potassium sulphate, and with equivalents between 119 and 115. (4.) Earth almost insoluble, didymium oxide, retaining energetically a quantity of the former earths. The first group contains merely two earths already known, yttria and terbia. The second group contains terbia, traces of decipia and of didymia, and a new earth, which the author designates provisionally as Yα. The third group contains a little terbia, a notable quantity of Yα, didymium oxide, and an earth Yβ, whose spectroscopic characters agree with those of M. Delafontaine's decipia, and better still with the samarium oxide of M. Lecoq de Boisbaubran.

The Electro-magnetic Gyroscope.—W. Fonvielle.—The author does not accept the explanation given by M. Jamin in the session of the Academy, April 12, since he has found it impossible to obtain rotation with induction coils in which the wire is very long.

Measure of Thermo-electric Electro-motor Forces on Contact of a Metal and a Liquid.—E. Bouty.—The results are given in the form of tables not capable of useful abridgment.

An Automatic Mercurial Pump.—G. Couttolenc.—Will be inserted at length.

On the Tropeines, Artificial Mydriatic Alkaloids.—A. Ladenburg.—The author has prepared and examined the tropeines of the following acids :—The salicylic, oxybenzoic, paroxy-benzoic, amygdalic, benzoic, and phthalic. Oxy-toluyl-tropine he names homatropine, on account of its homology with atropine.

On Gelose.—H. Morin.—Gelose is a mucilaginous substance imported from China under the name Ta-ô. Its properties are described at length, but its composition is not given. Although very different in its origin it is in many respects analogous with the gums. Thus it is transformed into mucic and oxalic acids by the action of nitric acid.

Ammonium Carbonate.—E. J. Maumené.—Two samples of this salt, differing very little in composition, yielded saturated solutions varying considerably in specific gravity, that of the one being 1·140, whilst the other only reached 1·060.

The Existence of Ammonia in Plants and in Muscular Flesh.—H. Pellet.—In 100 grms. of ox flesh the author found 0·15 grm. ammonia.

Sophistication of Commercial Silicate of Soda.—F. Jean.—The sample in question gave on analysis :—

Soda combined with silica	8 54
Carbonate of soda	6·36
Soda-soap	2·00
Silica	21·40
Ferric oxide, alumina, traces of lime	0·74
Alkaline chlorides and sulphates	0·66
Water	60 05
Matter not determined, and loss	0·25

This sample of silicate of soda contained therefore 2 per cent anhydrous soap, but as such a solution forms a jelly on cooling the object of its introduction was evidently to thicken the silicate, giving it the appearance of a very concentrated product, and to prevent its strength being taken with the hydrometer.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. No. 2, 1880.

Synthesis of the Homologues of Hydrocarbostyril and Chinolin.—A. Baeyer and O. R Jackson.—The formation of carbostyril and hydrocarbostyril takes place exactly in the same manner as that of cumarin and hydrocumarin. If normal phenyl-valerianic acid is treated with nitric acid and afterwards reduced, no substance resembling hydrocarbostyril is obtained. The authors describe the preparation and properties of phenyl-ethyl-propionic acid, of ethyl-hydrocarbostyril, of ethyl-chlor-chinolin, ethyl-chinolin, and normal phenyl-valerianic acid.

On Diphenyl-di-imido-naphthol.—B. Goës.—By the action of aniline and the toluydines upon di-imido-naphthol there are formed a number of very beautiful bodies, particularly characterised by their stability. The reaction takes place with elimination of hydrogen, the two imid-hydrogens being substituted by phenyl groups. The authors particularly describe the action of aniline upon di-imido-naphthol.

Constitution of Nitroso-dimethyl-meta-toluydin.—C. Riedel.—The author concludes that in this compound the nitroso-group occupies the para-position with respect to the amido-group.

Action of Phosphonium Iodide upon Carbon Disulphide.—H. Jahn.—The gaseous products of the reaction are hydrogen sulphide and phosphide and light hydrogen carbide.

Certain Derivatives of Ortho- and Para-toluydin.—G. Staats.—Among these products are ortho-tolyl-sulphurea and the corresponding para compound ; ortho-tolyl-ethyl-sulphurea and the para compound ; ortho-tolyl-phenyl-sulphurea, ortho-tolyl-glycocoll, and aceto-ortho-homo-paroxy-benzaldehyd.

Formation-heat of Cuprous Chloride.—J. Thomsen.—The author considers that his results, 59,625 cals., is much nearer the truth than that obtained by M. Berthelot, 54,200 cals.

Niobite from the Iser Mountains.—J. V. Janovsky.—The author gives analyses of his specimens in comparison with those of iserite, nigrine, and iserine as given by Rammelsberg.

New Method of Determining the Specific Gravity of Liquids.—H. Sommerkorn.—Already noticed.

Composition of the Anethol Derivatives.—F. Landolph.—The author describes the following of these compounds :—Anethol-dihydride, anethol-tetrahydride or anethol-camphor, anethol-hexahydride or anethol-borneol, and the condensation-products obtained by the action of alcoholic potassa upon anethol, and upon mono-chlor-anethol.

Determination of Aqueous Vapour in the Atmosphere.—F. Rüdorff.—The author's process cannot be intelligibly described without reference to the figure of his apparatus.

The Formation-heat of Cyanogen.—J. Thomsen.—Another difference with M. Berthelot. The author had observed as early as 1854 the absorption of heat on the formation of cyanogen, which, according to M. Berthelot, had been ignored till pointed out by him in 1864.

Pyridin-tricarbonic Acid from the Cinchona Alkaloids.—S Hoogewerff and W. A. van Dorp.—Remarks on a paper by Skraup (*Berichte*, xii., p. 2331).

Quantitative Determination of the Oxygen Dissolved in Water.—J. König.—Inserted at length.

Reactions taking place in Presence of Aluminium Chloride and Bromide.—G. Gustavson.—The author points out that he had already answered the question which Kekulé and Schrötter propose to deal with in their memoir on the conversion of propyl-bromide into iso-propyl-bromide (*Berichte*, xii., p. 2280).

Preparation of Bioxy-fumaric Acid in a State of Purity.—S. Tanatar.—The nickel salt is the best medium for separating this acid from the oxalic and the fumaric acids.

Etherification of the Non-saturated Mono-basic Acids.—N. Menschutkin.—The author considers these acids under three groups, the primary, secondary, and tertiary. The etherification of all is strictly analogous.

The Structure of Sorbic and Hydrosorbic Acid.—N. Menschutkin.—Not suitable for abstraction.

Maleic and Malic Acids from Bibrom-propionic Acid.—S. Tanatar.—Bibrom-propionic acid was heated with an excess of potassa-lye, and an aqueous solution of potassic cyanide was then added, the boiling being continued for six to eight hours in a cohobator.

Belladonnine.—K. Kraut.—This base is probably isomeric with atropine.

A New Chemical Photometer for Determining the Intensity of the Ultra-violet Rays of Daylight by means of Mercury Oxalate, and Contributions to the Photo-chemistry of Mercuric Chloride.—J. M. Eder.—The author recommends a mixture of mercuric chloride with neutral ammonium oxalate. The photometer is filled with 2 vols. of a solution of 40 grms. ammonium oxalate in 1 litre water mixed with 1 vol. of a solution of 50 grms. sublimate in 1 litre of water. Before use it is exposed to light till the deposit of mercurous chloride begins to occasion a turbidity, and is then filtered. The mixture can be kept without change in the dark. Light which has passed through red, yellow, or yellowish green glass is inactive, and the decomposition is mainly produced by the ultra-violet rays.

Chemical Composition of Pyroxyline and Formula of Cellulose.—J. M. Eder.—A very extensive memoir, incapable of abstraction.

Synthesis of Methyl-ketol, an Isomer of Skatol.—A. Baeyer and O. R. Jackson.—This substance, C_9H_9N, is distinct in its properties both from skatol and indol. The authors are endeavouring to ascertain whether it is the methyl derivative of an unknown base, isomeric with indol.

Further Contributions to a Knowledge of the Putrefaction-products of Albumen.—E. and H. Salkowski.—An examination of the occurrence of aromatic oxy-acids among the putrescent-products of albumen, and of a substance which forms skatol.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.
No. 73, January, 1880.

Report Presented by MM. de Luynes and H. Peligot on behalf of the Committee of Economic Arts on a New Laboratory Balance Constructed by M. Deleuil.—This balance carries 3 kilos. in each pan, and is sensitive to 5 m.g. Its construction cannot be intelligibly described without the accompanying illustration.

No. 74, February, 1880.

This number contains no chemical matter.

Chemisches Central-blatt.
No. 12, March 18, 1880.

The Electric Light Applied to the Examination of the Natural Cavities of the Human Body.—This discovery has lately been claimed by Herr Nitze in opposition to M. Gustave Trouvé.

The New Seismograph of M. Galli.—This apparatus cannot be intelligibly described without the accompanying illustration.

The Tommasi Universal Electrical Company.—An exposition of the advantages of the system of electric lighting devised by M. Tommasi.

Justus Liebig's Annalen der Chemie,
Band 200, Heft 3.

Ammonium Nitrite and the Secondary Products Obtained during the Ozonisation of the Air by Moist Phosphorus.—A. R. Leeds.—The chief secondary product of the ozonisation of moist air is phosphoric, not phosphorous acid. The dense white clouds produced, and commonly taken for ammonium nitrite, are chiefly phosphoric anhydride. At the end of the experiment no ammonium nitrite is present, even if it is formed previously.

The Hydroxyl-valerianic Acids and Angelicic Acids.—Dr. W. v. Müller.—By the oxidation of valerianic acid the author obtains an angelicic acid, possessing a much higher melting-point than that of Buchner.

On Cinchona Barks.—O. Hesse.—The author considers that his Cusco bark is probably identical with the aricineferous bark of Pelletier and Coriol.

On Gardenin.—J. Stenhouse and C. E. Groves.—The authors describe the extraction of gardenin, the terpen of *Gardenia lucida*, gardenic acid, acetyl-gardenic acid, and hydrogardenic acid.

A New Volumetric Method for the Determination of Manganese and Cobalt.—C. Rössler.—This memoir has been already noticed under *Berichte der Deutschen Chem. Gesell.*, xii., 125.

The Camphen of Borneol and of Camphor.—J. Kachler and F. V. Spitzer.—The two camphens are identical. The derivatives C_{10}, H_{16}, HCl are identical with each other, and with borneol chloride. Camphor is an addition-product of camphen and oxygen.

Annalen der Physik und Chemie.
Heft 3, No. 11, 1879.

Phenomena of Phosphorescence.—B. Stürtz.—The author, along with M. Müller, has extended the experiments of Crookes and Maskelyne upon the phenomena of phosphorescence in a very high vacuum, to a series of substances:—Phosphate of magnesia, wolframite, cerussite, adular, double spar, apatite, Franklinite, lazulite, dolomite, red spinell, cobalt glance stannite, baryta, chrome iron, lepidolite, zinnwaldite, ankerite, greenockite, pectolite, cinnabar, borax, leucite, sanidine, and a meteorite from Java, all of which became phosphorescent. Brucite, magnesite, orthoclase, kaolin, axinite, silicate of zinc, zinc spar, Fergusonite, apophyllite, and cœlestine appeared phosphorescent only if previously heated to redness.

MEETINGS FOR THE WEEK.

MONDAY, 31st.—Royal Geographical (Anniversary), 2.
TUESDAY, June 1st.—Zoological 8.30.
—— Royal Institution, 3. Mr. Fiske, "American Political Ideas."
—— Mineralogical, 8. Prof. M. Forster-Heddle, "On a New Face on Crystals of Stilbite f om Scotland and Western Australia." A. E. Arnold (communicated by J. H. Collins), "On a Portable Chemical Cabinet for Quantitative Work." J. H. Collins, "On Kaolinite and Kaolin."
WEDNESDAY, 2nd.—Obstetrical, 8.
—— Society of Public Analysts, 8. F. P. Perkins, "On the Determination of Organic Carbon in a Water Residue." G. W. Wigner, F.C.S., "Note on the Analysis of some Samples of Chian Turpentine," and "On the Relating of the Scale of Baumé's Hydrometer for Liquids Heavier than Water to the Specific Gravity." C. Heisch, F.C.S., "On the Acts Regulating the Sale of Poisons and Poisonous Colours in Sweden."
THURSDAY, 3rd.—Royal Institution, 3. Mr. T. W. R. Davids, "Buddhist Sacred Books."
—— Royal Society Club, 6.30.
—— Chemical, 8. Mr. W. H. Perkin, "On Some Products of the Oxidation of Paratoluidine." A. Dupré, "The Detection of Foreign Colouring Matters in Wine." E. Frankland and D. A. Louis, "On the Action of Zinc Ethyl on Azobenzene." E. Frankland and J. Castell Evans, "On the Action of Zinc Ethyl upon the Azonitriles." W. N. Hartley, "On the Relation of Actinic Absorption to the Chemical Structure of Carbon Compounds." Cuthbert Neison, "On the Luminosity of Calcium Sulphides."
FRIDAY, 4th.—Royal Institution, 8. Mr. H. H. Statham, 'An Analysis of Ornament," 9.
—— Geologists' Association, 8.
SATURDAY, 5th.—Royal Institution. Prof. Morley, "The Dramatists before Shakespeare," 3.

THE CHEMICAL NEWS.

Vol. XLI. No. 1071.

ON A COMBINATION BLOWPIPE FOR GLASS-WORKING.

(Patent.)

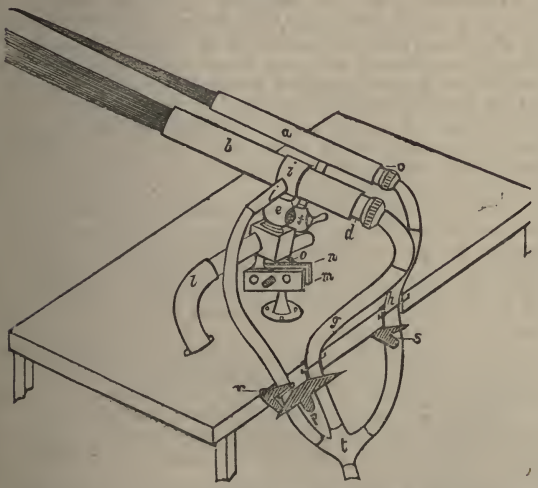
By CHARLES H. GIMINGHAM, F.C.S.

At the present advanced stage of chemical and physical inquiry, when so much depends upon the construction of original apparatus, into the composition of which no material enters so largely as glass, it is impossible to over-estimate the value, to workers in almost all branches of science, of even a slight proficiency in the art of manipulating that substance in the blowpipe flame.

In the course of my experience in experimental science I have frequently met with difficulties in the construction of originally designed glass instruments, which have necessitated improvements in the ordinary glass-blowing apparatus, in order to properly overcome them. Such experiences have led me to devise, and from time to time improve, a blowpipe for myself, with which I may safely say anything in the way of glass work within the limits of possibility may be done with far greater ease than with any ordinary blowpipe.

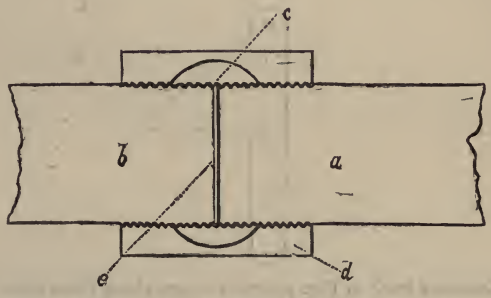
The description and woodcut given below, taken from the instrument that has assisted me so much in carrying out the experiments in Mr. Crookes's later researches, with which I have had the honour of being so closely associated, will, I trust, be of service to those who wish to be able to construct for themselves small pieces of originally-designed glass work, which are so difficult to obtain from the instrument maker, and which the ordinary workman seems incapable of comprehending.

Fig. 1.



a and *b* are two brass tubes, ¼" and ⅜" in diameter respectively, *a* being used for the production of the small pointed blowpipe flame, and *b* for the large flame or blast. Gas is supplied to these two tubes separately by the taps *e* and *f*, both of which have long lever handles projecting out to the right of the instrument. I may here mention that these lever handles to the taps are very necessary when rapidity is required in turning the gas on or off, as a knock with the finger up or down is then generally sufficient for the purpose. The inner sliding pieces of brass tube *c* and *d* carry the air jets, the one for the blast being about 5 m.m., and that for the small 1 to 1½ m.m. diameter. These sliding tubes are necessary in order to adjust the distance of the jets from the end of the tubes of which they form the centre, the form of the flame obtained being greatly dependent upon this adjustment. The jets are supplied with air from foot bellows through the india-rubber tubes *g* and *h*. In the interior of the support (*i*) for the large tube *b*, is turned a groove, into which the small brass pipe, *j*, conducts air from the bellows through the india-rubber tube, *k*. The rate at which the air is forced into the tube *b* from the groove, is regulated once for all by screwing *b* into its support (*i*) until it nearly meets the other part of the tube, which is screwed in from the opposite side, thus forming a narrow slit, through which the air is admitted equally all round (see Fig. 2) Mixing the air with the gas in this

Fig. 2.



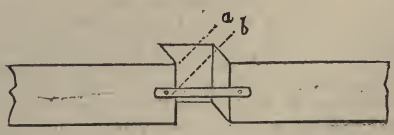
Section.

a and *b* are the two parts of the tube *b*, Fig. 1. *d*, the support Fig. 1. *c*, the groove into which the air is conducted by the little pipe *j*, Fig. 1. *e*, the circular slit formed by *a* and *b*, nearly meeting in the centre of the groove.

manner causes its complete combustion at the mouth of the tube, the flame issuing similarly to that from a very large Bunsen burner, but much broader. The india-rubber pipe, *l*, which comes up through a hole in the bench, supplies the gas from the main.

The whole instrument is supported from the bench on some kind of universal joint, which enables the operator to direct his flame in any direction he pleases. The best arrangement for this purpose consists of two brass balls about ⅜" diameter, one attached to the instrument, the other screwed into the bench. These two balls are clamped together by two pieces of brass or iron, *m* and *n*, through which passes a thumb-screw, *o*. This forms a joint which will allow the blowpipe to be placed in almost any position, and is capable of far more motion than the ordinary ball and socket, at the same time being very simple and easy of construction.

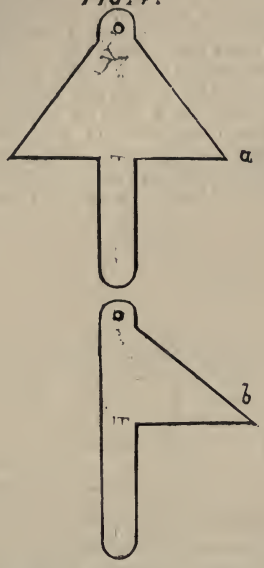
Fig. 3.



The air from the bellows is divided by a three-way piece, *t*, from which india-rubber pipes, *k*, *g*, and *h*, proceed to the different parts of the blowpipe. These three india-rubber pipes which pass the bench in little nicks (Fig. 3, *a*) cut in its edge, are kept in their places by pieces of brass screwed over them. The passage of the air is stopped by simply kinking the india-rubber tubes, which is quite sufficient for the purpose, and to a great extent

does away with the destruction of the tubes by excessive pinching. This operation of kinking, and the consequent changes in the direction of the wind from the bellows, is brought about most successfully and rapidly by means of brass levers (cut out of metal about $\frac{1}{16}$" thick) of the shape shown in Fig. 4, *a* and *b*.

FIG. 4.



Referring back to Fig. 1, it will be seen how these pieces of brass are used. The double one, *a* (Fig. 4), is screwed to the under side of the bench (see *p*, Fig. 1), midway between the india-rubber tubes, *k* and *g*. It will be seen that when the projecting arm of this lever is turned towards the right the tube *g* will be doubled under the bench, and consequently kinked sufficiently to stop the passage of the air from the bellows. On the other hand, if it be turned towards the left the air will be stopped in the tube *k* in the same manner, at the same time opening *g*. In this way we are able to change the flame from the large blue or Bunsen flame to the blowpipe blast, or *vice versâ*, by simply pushing this lever to and fro. Two single levers are used of the shape shown in Fig. 4, *b*, and represented in Fig. 1 at *r* and *s*. *r* is screwed on to the upper side of the bench and used to kink *k*, when the little pointed flame is only at work, it being then necessary to shut both the blast and Bunsen off. The use of the lever *s* is obvious from the foregoing explanations, viz., to shut off the air when the small flame is not required.

The use of the instrument will be easily gathered from the foregoing description, and therefore little more need be said regarding it. In order to avoid depositing soot over the room, and the injurious effect of the large flickering flame upon the eyesight, the operator must always use the Bunsen flame for heating up the glass, which necessitates the almost continuous use of the bellows; for this reason a water blower or other source from which a continuous blast might be obtained would be a great luxury, but is by no means necessary. I have always used the ordinary double action bellows, which answer every purpose. In the adjustment of the flames the jets should be exactly in the centre of the tubes containing them, and about 10 m.m. below the end of the outer tube in the case of the large flame, and about 15 m.m. in that of the small, but these distances must be slightly varied by sliding the telescope tubes, *c* and *d*, in and out till the desired flames are obtained. The large flame should be equal all round, have a fairly sharp outline, give a steady roar, and heat in the middle as well as at its edge. The small flame should be moderately long, sharp pointed, and require a good deal of pressure on the bellows to make it hiss. In future numbers of this journal I hope to go more fully into the details of the blowpipe flame and its use as applied to chemical and physical manipulation.

ORGANIC MATTER IN WATER.

By C. T. KINGZETT, F.I.C., F.C.S.

In a paper* recently communicated to the Chemical Society, I endeavoured to trace the gradual destruction of the organic matter present in water, as induced by animal ferments of the genus *Vibrio*, and to show that as this matter becomes less in quantity it becomes (under generally accepted teachings) more pernicious in quality. It will be convenient to explain the meaning of this statement a little more fully. In his paper, "On the Processes for Determining the Organic Purity of Potable Waters,"† Dr. Tidy, throughout, evidently regards putrescent matters as the most dangerous ones that can be present in potable waters, and he also cites an expression from a publication of Dr. Frankland's bearing the same interpretation, and, further, one from Dr. Angus Smith, to the same effect. Under these circumstances it seemed to me that a water might be found containing such a small amount of organic matter in a given volume that it would be passed by Tidy's process as of "great organic purity," and yet might, under given conditions, pass into a state of putridity, and therefore become pernicious, and I confess this is a difficulty that still remains before me. To instance this:—It is possible to dissolve an amount of gelatine in water, which, upon subsequent examination by Tidy's permanganate method, may be passed as fit for potable purposes, and yet, if we place this water out of intimate contact with oxygen, it will pass into such a putrefactive condition that it would unhesitatingly be condemned by all analysts. And yet the water in this state would use up less permanganate of potassium than in the stage before putrefaction, because this latter process of fermentation necessarily decomposes and destroys the matter in which it is induced.

In connection with this subject it is perhaps desirable to refer to a recent publication,‡ by Messrs. F. Tiemann and C. Preusse. These authors seem to have repeated some of my experiments, and they found (with me) that "the products of putrefaction have a slightly stronger reducing action than the original compound." But had they kept their putrefied solutions a little longer they would have found that the reducing action diminishes very regularly day by day, as I observed during periods of more than a hundred and fifty days.

In explanation of this it must be remembered that putrefaction in its essence is an act of hydration only, no organic matter being lost, but only prepared to undergo rapid oxidation. Later on, this oxidation sets in, and gradually completes itself, at least upon the surface of the solution in the body of which the organic matter has been first hydrated.

In order to record a few further experimental observations, I may be permitted to reproduce here the report of Experiment 4 from my paper above alluded to.

"Expt. 4 (November 3, 1879).—4 or 5 lbs. of raw lean beef was minced and macerated in pure water at about 40° C. The extract contained 3 per cent (?) solid matter, dry at 100° C.

"A. 200 c.c. of this extract was placed in a stoppered bottle of about 250 c.c, capacity.

"B. 200 c.c. of the same extract was placed in a stoppered bottle of this exact capacity.

"C, 50 c,c. was exposed to 47·5 c.c. of air over mercury."

* "Contributions to the History of Putrefaction," Part I., *Journ. Chem. Soc.*, January, 1880.

† *Journ. Chem. Soc.*, January, 1879.

‡ *Journ. Chem. Soc.*, April, 1880 (from *Berichte*, xii., 1906-1924).

Initial Oxygen-capacity of 5 c.c.	After 96 hours.	192 hours.	278 hours.	374 hours.	926 hours.	155 days.
A. .. .. 0·0073959	0·006942	0·0064614	0·00631455	0·006942	0·00643552	0·003604
B. .. .. 0·0073959	—	—	0·006942	0·007743*	0·00685776	0·00289
C. .. .. 0·0073959	Volume of gas in air-tube = 44·5 c.c.			0·0071289	0·00643552	0·003604

* After this examination a quantity of this extract was placed in a bottle of its precise measure, and at the 926 hours' stage the oxygen-capacity was found to be 0·0075712.

It will be seen that I have added to the table as it originally stood, the observations made after 155 days.

Of course it will be understood that in the case of B, after the first examination, the solution was no longer out of contact with air, the volume of which necessarily increased with each examination.

The results just expressed may be put in the following form :—

Grms. of Oxygen used up by a Gallon of the Extract from 36,000 *c.c. of Acidified Standard Permanganate* (1 *c.c.* = 0·001334 *grm. Oxygen*).

	At the Start.	After 39 days.	After 155 days.
A.	6·656	5·79	3·243
B.	6·656	6·17	2·601
C.	6·656	5·79	3·243

Thinking it would be interesting to ascertain, now, the effect of passing a current of air through these solutions, the putrid extract in A was subjected to a good current of air for twenty-four hours, with the effect of reducing its oxygen-capacity from 3·243 to 2·234 grms. per gallon.

Similarly, a current of air was blown through B for seventy-two hours, but in this case the oxygen-capacity was not diminished, apparently. I state this with all reserve, because I omitted to ascertain what loss of water (if any) had occurred by evaporation. In each case the putrid character of the solutions, so far as the senses are concerned, was almost entirely removed.

It would be of extreme interest to make a large series of experiments upon the aërial oxidation of animal and vegetable matters in a state of solution, or solution and suspension, both in the putrid and fresh state, and for such a purpose a current of air passed into the fluid gives some obvious advantages over mere exposure to air.

Now, if it be granted that putrescent matters are pernicious, surely waters containing them should be condemned; and yet, if waters be divided into the four classes, as done by Dr. Tidy (*Journ. Chem. Soc.*, January, 1879, p. 91), it would be possible to introduce something like 50 fluid grains of the putrid extract—referred to above (B) as being examined after 155 days—into a gallon of chemically pure water without removing such from the class of "waters of great organic purity." Similarly 170 fluid grains could be introduced so as to obtain a water of "medium purity," and 253 fluid grains to get a water of "doubtful purity." I cannot help regarding these facts as being of great significance.

Such putrid extracts as here referred to swarm with low forms of life; besides which, they are known to contain *sepsin*, which is a blood-poison, as proved by Burdon-Sanderson.

Without committing oneself to the germ-theory of disease, it really appears that chemical analysis must of necessity fail to discover in waters the germs of contagious diseases, assuming that such germs have a real existence. And, for the matter of that, it is not easy to see how even biological science is going to make any such discovery. Although—as Prof. Huxley reminded us at the Chemical Society the other evening—we may not be sufficiently acquainted as chemists with the teachings of biology, I do not think we can be accused of disregarding altogether the almost undiscoverable and infinitesimal contagious particles, whether they be morphological germs or degraded protoplasts (bioplasts), or neither.

In determining, then, whether a given supply of water is fit for potable purposes, we can only act upon the very broadest basis, and from a general sanitary standpoint, being assisted with our chemical investigations; but neither chemists nor biologists can yet presume to state whether a given water does or does not contain the infectant of any communicable disease. At the same time I believe, with profound respect for the biologists, the chemists are entitled to give a better judgment than the representatives of any other branch of Science.

Dr. Tidy very pertinently remarked that in enumerating the diseases which appear to be, or which have been proved to be, dependent upon so-called germs (or, perhaps better, "parasites"), Prof. Huxley happened to mention *the only three there are*, viz., relapsing fever, splenic fever, and pig-typhoid; and even the warmest supporters of the germ-theory cannot ignore the existence of the graft-theory, nor the fact that there is a very strong—indeed, at present, an impregnable—position occupied by those who are reluctant to apply to all contagious diseases the explanation that has been, we will say, established for three or four only, and which differ not immaterially in nature from (say) cholera, small-pox, and scarlet fever. For my part I cannot permit myself to forget, among other important researches, those of Dr. Creighton on the infectiveness of cancerous tumours, and they do not by any means adapt themselves to the necessities of the germ-theory of disease.

One other point, and I have done. In his paper on River Water,* Dr. Tidy refers to the fact, apparently well established, "that the progress of such a disease as cholera is not *down* a river at all (as we should expect it to be), but in the opposite direction" (page 322); and he regards the promise made by the Rivers' Pollution Commissioners, of "absolute immunity from epidemics of cholera," conditionally that the Metropolis were supplied with the deep well water of the Kent Company, as at once startling and bold.

I will conclude by quoting, in reference to this subject of cholera, a few words† of Dr. Cuningham, the Imperial Sanitary Commissioner of India, from the Fourteenth Report. He says that "Cholera almost invariably travels, not down, but up the great drainage channels of the country." And again, "Even if it had been shown beyond all manner of doubt that cholera is due to a specific poison, and that this poison resides in the evacuation, it would require very strong proof before the accidental pollution of the water supply over enormous areas could be accepted as the explanation of an epidemic year; for even in a non-epidemic year there is no want of cholera cases amply sufficient to contaminate the water. But as the very existence of the cholera germ has itself still to be established, as well as the opinion that it resides in the discharges, not only is the chain of argument imperfect, but every important link in it seems to be wanting."

THE ALKALOIDS.

On the occasion of the visit to London of Dr. Burggraeve, Emeritus Professor of Anatomy and Surgery of Ghent University, and Member of the Royal Academy of Medicine of Belgium, several eminent members of the medical profession met, on the 27th ult., at the residence of Dr. Phipson, F.C.S., to listen to a discourse by the veteran Belgian Professor, in which he disclosed the history of his researches upon the alkaloids, and their application to the treatment of diseases by what is termed the dosimetric method.

Professor Burggraeve, in spite of his great age, addressed the meeting with wonderful fluency and without the

* *Journ. Chem. Soc.*, May, 1880.
† *Practitioner* for August, 1879.

slightest fatigue for upwards of two hours, illustrating his remarks by numerous interesting cases, taken for the most part from his own practice. His object was to show how such powerful agents as strychnine, hyoscyamine, aconitine, veratrine, &c., can be applied in medicine as safely and efficiently as quinine in cases of intermittent fever. He demonstrated their action in fevers of all kinds and in other forms of disease, and insisted energetically upon the absolute necessity of a complete reform in our present system of therapeutics.

ON THE

RECOGNITION OF ALIZARIN, ISO-PURPURIN, AND FLAVO-PURPURIN IN MIXTURES,

AND ON THE

QUANTITATIVE DETERMINATION OF ALIZARIN.

By E. SCHUNCK and H. ROEMER.

ALIZARIN, iso-purpurin, and flavo-purpurin display so characteristic reactions that their recognition, especially in a state of purity, presents no difficulty. It is otherwise when they are present in a mixture, the separation of which into its constituents, each free from admixture with the others, is difficult, or even impossible, when the quantity at disposal is small. These bodies, and also their compounds, vary little from each other in their behaviour with solvents, and the characteristic reactions above-mentioned are chiefly changes of colour, which become untrustworthy, or at least less distinct, as soon as the respective bodies are not met with in a state of purity. The authors have seached for a practicable process for their separation or recognition when small quantities only are concerned. They have succeeded by fractionated sublimation. Alizarin begins to sublime at 110°, flavo-purpurin at 160°. and iso-purpurin at 170°. The first-mentioned body may be easily removed from a mixture of the three if the temperature is kept below 160°. Greater difficulty attends the sublimation of flavo-purpurin from the residual mixture with iso-purpurin. This, however, is scarcely necessary, as the two compounds may readily be distinguished under the lens in a sublimate obtained above 170°. Iso-purpurin sublimes in massive well-developed crystals, whilst flavo-purpurin forms fine reddish yellow needles. These compounds can, moreover, be separated in the moist way, since flavo-purpurin dissolves readily in benzol, in which iso-purpurin is almost insoluble. The purpurins, when separated in this manner, show distinctly the properties described by the authors in *Berichte*, ix., 680. The operation is performed by simply heating the mixture in an air-bath between two glass disks kept a few millimetres apart by a leaden ring.

As the mixture is not carbonised even at 200°, the authors have applied the process to the quantitative determination of alizarin in such mixtures as the above. Such an application is the more valuable, as commercial alizarins almost invariably contain an admixture of the purpurins, and as hitherto no ready method of determining the proportion of actual alizarin has been published.

As an experiment the authors exposed a mixture of pure flavo-purpurin and alizarin to a prolonged heat of 140°. From time to time the sublimate was removed from the upper glass, and heat was again applied till it ceased to be re-formed. This may easily be ascertained by examination with the microscope or by moistening the upper glass with a solution of potassa. The weight of the residue then became constant. The mixture was composed of 90·91 flavo-purpurin and 9·09 per cent alizarin. The analysis showed 8·91 per cent of the latter. On examining commercial alizarins in this manner it is recommended first to remove any anthraquinon, oxy-anthraquinon, anthra- and iso-anthraflavic acid present.—*Berichte der Deutschen Chemischen Gesellschaft.*

A METHOD FOR THE PROXIMATE ANALYSIS OF PLANTS.*

By HENRY B. PARSONS.

AT the request of my friend and former instructor, Prof. Albert B. Prescott, of the University of Michigan, I have prepared the following scheme for the analysis of plants. This method will appear, in substance, in his new Proximate Organic Analysis, now nearly completed.

The plan submitted is the outgrowth of a quite varied experience in the proximate analysis of plants; no claim to originality is made, the sole aim being to arrange in one simple scheme those methods best suited to ensure accuracy.

It must be premised that no one method is applicable in all cases, and that the operator will so modify and adapt the proposed processes as to best attain the truths he seeks. If the present scheme shall serve merely as an example, to be improved upon as discoveries multiply, it will at least have served to stimulate to the more thorough study, this side the Atlantic, of a much neglected, yet very important, branch of analysis. The American student, when first entering upon the study of plant analysis, is perplexed and disheartened, owing to the lack of any elementary treatise in which he may find directions for the quantitative estimation of the various plant constituents. The works of Rochleder and Wittstein, while giving most valuable assistance in the investigation of special constituents and their separation from large quantities of the crude herb, still fail to give clear and practicable directions for the quantitative estimation of each constituents. Von Mueller's latest enlarged edition of Wittstein's Plant Analysis gives a scheme, most excellent in many respects, yet cumbered with tiresome methods of extraction and manipulation, which serve to unnecessarily lengthen the time required for making the analyses without increasing the accuracy of results obtained.

Too many American analyses of plants have been summarised thus: "The plant contains gum, resin, tannin, a volatile oil, and a peculiar bitter principle, to which may be ascribed its medicinal activity." The foreign journals bring occasionally most excellent examples of accurate examinations of vegetable substances; as instances may be cited the examination of ginger, by J. C. Thresh,† and of ergot,‡ aloes,§ and other articles, by Prof. Dragendorff. To these sources the student must look for his best models, until a more thorough and systematic training is given American students in proximate organic analysis.

In following the plan now presented, the use of the apparatus for re-percolation is strongly urged for the extractions with benzole, alcohol, and other volatile solvents. A very simple and inexpensive apparatus has been described be various American and foreign chemists.‖

"In any convenient water-tight vessel is a worm of block tin pipe, having an internal diameter of 9 m.m., and a length of about 2·5 metres. The lower (external) part of this worm is fitted, by an ether-soaked, velvet cork, to a glass percolator having a diameter of 4 c.m., a length of 20 c.m. to the constriction, and 5 c.m. below. Within this percolator is a smaller tube, flanged at the top and bottom, and suspended by fine platinum or copper wires. This tube has a diameter of 2·5 to 2·8 c.m., and a length of 14 c.m.; the bottom is covered by filter paper and fine washed linen,¶ tied on by linen thread. The weighed

* From the *American Chemical Journal*, vol. i., No. 6.

† *Pharm. Journ. Trans.* (3), 10, 81, August, 1879

‡ *Pharm. Journ. Trans.* (3), 6, 1001, June 17, 1876.

§ *Werthbestimmung*, 1874, p. 110.

‖ B. Tollens, *Ziet-ch. f. Anal. Chem.* (17), 320, 1878; *New Remedies*, (7), 335, November, 1878; W. O. Attwater, *Proc. Am. Chem. Soc.* (2), 2, p. 85; S. W. Johnson, *Am. Journ. Sci. Arts*, (13), 196; H. B. Parsons, *New Remedies*, (8), 293, October, 1879.

¶ In place of the linen and filter paper may be substituted fine brass or platinum wire gauze. Asbestos suspended in water may then be poured in to form a fine felt. The tube can then be dried and weighed, and the amounts extracted may be found by the loss of weight of the tube and substance. A little experimentation will show the operator how to prepare and use the tube. It is but an adaptation of the Gooch's filter here recommended.

sample of the finely powdered herb is placed within this tube for extraction. A light glass flask, weighing about thirty grms., is fitted by an ether-soaked cork to the outer percolator." Having introduced the solvent into this glass flask, the connections are made secure, and heat is applied, by a water-bath, to the flask. If the liquid is too slowly volatilised, the addition of a little common salt to the water in the bath serves to remove the trouble.

Next in importance is the use of a good tared filter. The form originally presented by F. A. Gooch* leaves little to be desired. It may be made by perforating with fine holes the bottom of an ordinary platinum crucible, and fitting it accurately to a perforation made in a large rubber cork; this cork connects it with a receiving vessel, which, in turn, is connected with a Bunsen's pump. Fine asbestos suspended in water is poured into the crucible, the air exhausted from the receiving vessel, add thus a firm thin layer of asbestos is deposited on the bottom of the crucible. After ignition and weighing, the crucible is ready for the reception of any precipitate which it is desired to separate and weigh.

The use of these two pieces of apparatus will eliminate two grave sources of error, viz., incompiete extraction of soluble matters, and inaccuracies introduced by the use of tared paper filters.

The other necessary apparatus is simple, and includes one or more platinum crucibles and evaporating dishes, accurate burettes and graduated cylinders, a good balance sensitive to at least 0·5 milligrm., and the ordinary glass and porcelain ware found in all laboratories.

It is assumed that whoever attempts the analysis of a plant is informed as to the normal constituents to be sought, that he has had considerable experience in inorganic analysis, and in the identification of the principal classes of proximate constituents which he now undertakes to estimate quantitatively. Accordingly tests for identification will not be here presented; they should, however, never be omitted. The necessity of recording in detail all physical and chemical peculiarities, with every weight that is taken, is self-evident.

A Method for the Proximate Analysis of Plants.

I. *Preparation of Sample.*

The air-dry specimen should be carefully examined, and all extraneous substances removed. The entire sample should then be ground, or beaten in an iron mortar, until it will all pass through a sieve having from forty to sixty meshes to the linear inch. After thoroughly mixing this sample, take of it about a hundred grms., which should be further pulverised until it will all pass through a sieve having from eighty to one hundred meshes to the linear inch. From this smaller portion remove all iron, derived from mill or mortar, by use of a magnet. Then place in a clean dry bottle, which should be labelled and securely corked. This small sample is for the analysis; the larger portion should be reserved for the separation of those proximate principles which seem, from the analysis, to be worthy of more extended investigation.

II. *Estimation of Moisture.*

Dry rapidly, at 100 to 120° C., two or more grms. of the sample; the loss of weight equals moisture, and occasionally a little volatile oil. In some cases it is best to dry at a lower temperature, and at other times the drying should be conducted in a stream of hydrogen or carbonic anhydride.

III. *Estimation of Ash.*

In a weighed crucible gently ignite two or more grms. of the sample until nearly or quite free from carbonaceous matter; the heat should not be permitted to rise above faint redness, or loss of alkaline chlorides may occur. Weigh this residue as *crude ash*, and in it determine:

a. Amount soluble in Water.—This portion may contain chlorides, sulphates, phosphates, and carbonates of potassium and sodium, also slight amounts of chlorides and sulphates of calcium and magnesium.

b. Insoluble in Water; Soluble in dilute Hydrochloric Acid.—The residue from *a* should be treated with a slight excess of hydrochloric acid, and evaporated in a porcelain dish over a water-bath until all free acid has been expelled; it should then be again moistened with hydrochloric acid, water added, and be filtered from any remaining insoluble substances. This treatment removes carbonates (with decomposition) and phosphates of calcium and magnesium, sulphate of calcium, and oxides of iron and manganese.

c. Insoluble in Water; Insoluble in dilute Hydrochloric Acid; Soluble in concentrated Sodic Hydrate.—Boil the residue from *b* with a solution containing about twenty per cent of sodic hydrate. This treatment removes combined silica of the ash. The residue still insoluble is sand and clay which adhered to the specimen; this residue should be separated, washed thoroughly, and weighed.

Always determine the amounts removed by the above treatment by weighing the dried, undissolved residues. The ash, as thus estimated, usually includes a little unconsumed carbon, together with more or less carbonic anhydride (CO_2), most or all of which was not originally present in the plant, but was produced by the combustion of the organic matter. For most purposes it is unnecessary to estimate and exclude from the ash this carbonic anhydride; where great accuracy is desired, a complete quantitative analysis should be made, the amount of each base and acid being determined, and in the statement of results only those should be included which existed originally in the plant. For this purpose it is necessary to burn from twenty to one hundred grms. of the sample; for further directions consult text-books on agricultural and inorganic analysis.

IV. *Estimation of Total Nitrogen.*

In half a grm. or more of the sample determine total nitrogen by combustion with excess of soda-lime, as directed by Prof. S. W. Johnson and E. H. Jenkins.* If later in the analysis no other nitrogenous substances are discovered, calculate the total amount of nitrogen to albuminoids by multiplying by 6·25. When other nitrogenous compounds are present, their content of nitrogen should be determined directly or by difference; after proper deductions have been made, the remaining nitrogen should be calculated to albuminoids.

V. *Estimation of Benzole Extract.*

In a suitable apparatus for repercolation completely exhaust 5 grms. of the sample with pure coal-tar benzole (specific gravity 0·85—0·88, boils at 80—85° C., leaves no residue when evaporated). The extraction requires from four to six hours' continued action of the solvent. Carefully evaporate this liquid to dryness in a weighed dish, and record its weight as *total benzole extract.* This extract may contain volatile oils and other aromatic compounds, resins, camphors, volatile or non-volatile organic acids, wax, solid fats, fixed oils, chlorophyll, other colours, volatile or fixed alkaloids, glucosides, almost no ash.

To the weighed extract add water, again evaporate on the water-bath, and complete the drying in an air-bath at 110° C. In absence of other vapourisable substances the loss of weight approximates the amount of *volatile oil.* If the presence of a volatile alkaloid is suspected (from a characteristic odour or an alkaline reaction), add a drop of hydrochloric acid to prevent its volatilisation. Camphors are partially dissipated by this treatments; hence, when they are present, this evaporation should be dispensed with.

Treat, now, the residue with a moderate amount of warm water, allow to stand until cool, then filter through fine paper by aid of a Bunsen's pump. In half of the aqueous filtrate determine *total organic matter* and *ash*; test the remaining half for *alkaloids*, *glucosides*, and *organic acids* by salts of lead, silver, barium, and calcium.

* *Proc. Amer. Acad. Sci.* (13), 342, 1878; *New Remedies* (7), 290, October, 1878; *Amer. Chem. Journ.*, 1, 317.

* "Report Conn. Agric. Exp. Station, 1878; Chemical News vol. xl., p. 28; *American Chemical Journal*, 1, p. 77.

Care must be taken not to mistake a slight amount of suspended matter, frequently resinous, for other substances actually soluble in water.

The still undissolved residue should be again removed from filters and dishes by solution in benzole, the benzole solution being again evaporated to dryness. Treat this residue with warm, very dilute hydrochloric acid, allow to cool, and filter through paper. The filtrate should be tested for *alkaloids* and *glucosides*. The amount extracted by acid, if any, may be determined by weighing the still undissolved residue. Treat this residue with several considerable portions of eighty per cent alcohol (specific gravity 0·8483 at 15·6° C.), allowing at least an hour for each treatment. Filter through paper and determine by evaporation the matter dissolved; this usually consists of *chlorophyll* with one or more *resins*, which may sometimes be separated by use of petroleum naphtha, chloroform, or similar solvents. Purified animal charcoal removes *chlorophyll* and *some resins* from alcoholic solution, while certain other resins are not removed. If *camphors* were present in the plant the greater portion will be found in the alcoholic liquid.

The substances undissolved by eighty per cent alcohol may be *fixed oil*, *solid fat*, *wax*, and very rarely a *resin*: their separation may be attempted by refrigeration and pressure, or by use of ether, chloroform, &c.

Recapitulation.

1. Loss by evaporation, with precautions: *volatile oil.*
2. Soluble in water: *alkaloids, glucosides, organic acids.*
3. Insoluble in water. / Soluble in dilute acids. } : *Alkaloids*, possibly *glucosides*
4. Insoluble in water. / Insoluble in dilute acids. } : *a.* Removed by animal charcoal: *chlorophyll, some resins.*
   Soluble in 80 p.c. alcohol. } *b.* Not removed by animal charcoal: *some resins.*
5. Insoluble in water. / Insoluble in dilute acids. / Insoluble in 80 p.c. alcohol. } : *wax, fats, fixed oils.*

It is frequently advantageous to extract the plant with petroleum naphtha (specific gravity 0·66—0·70, boils at about 50° C., wholly volatile) before treatment with benzole; by reference to the accompanying table of comparative solubilities it will be seen that this treatment may serve to separate fixed and volatile oils and some resins and colours, from certain solid fats, wax, other resins and colours.

Where benzole of sufficient purity cannot be had, pure chloroform is the best substitute. The use of ether is objectionable in this place, and its solvent properties are less distinctly marked than are those of naphtha, chloroform, and benzole; in other words, more plant constituents are sparingly soluble in ether than in the above mentioned solvents. Consequently many substances which should properly be extracted by 80 per cent alcohol, would be sparingly dissolved if ether were used, while benzole, chloroform, and naphtha would have no perceptible solvent action upon them; tannic acids may be cited as instances illustrating this point.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

A MEETING of this Society was held on May 22, at Cambridge. On arrival there the party had luncheon at St. John's College, which had been kindly placed at the disposal of the Council by the College authorities. Prof. W. G. ADAMS occupied the Chair; and Mr. WARREN DE LA RUE proposed a vote of thanks to the Master and Senior Fellows of the College for providing the hall.

After some remarks from Prof. ADAMS, the party proceeded to the Cavendish Laboratory, where Lord RAYLEIGH, Vice-President of the Society, presided.

The routine business of the meeting being waived, Lord RAYLEIGH described a plan for limiting the slit of a

TABLE OF COMPARATIVE SOLUBILITIES.

Substances.	Water.	Ab. Alcohol.	80 per cent Alcohol.	Ab. Ether.	Chloroform.	Benzole.	Pet. Naph.	10 per cent Ammonia.	Ammonic Cupric Oxide.	H_2SO_4,H_2O Sp. gr. 1·78.	Fehling's Solution.	Lead Subacetate.
Volatile oils ..	Sp	Sol	Sol	Sol	Sol	Sol	Sol	Sol	—	—	—	—
Fixed oils	Ins	Ins?	Ins	,,	,,	,,	,,	,,	—	—	—	—
Wax	,,	Sp	Sp	Sp	Sp	,,	Sp ?	Ins	—	—	—	—
Solid fats	,,	,,	,,	,, ?	,, ?	,, ?	,, ?	,, ?	—	—	—	—
Chlorophyll ..	,,	Sol	Sol	Sol	Sol	,,	,,	,,	—	—	—	—
Soft resins	,,	,,	,,	,,	,,	,,	Sol	,, ?	—	—	—	—
Hard resins ..	,,	,, ?	,,	,, ?	,, ?	,, ?	,, ?	Sol ?	—	—	—	—
Glucose	Sol	Ins	Sp	Ins	Ins	Ins	Ins	,,	—	—	Reduced	Not prec
Sucrose	,,	,,	,,	,,	,,	,,	,,	,,	—	—	Not reduced†	,,
Tannin	,,	Sol	Sol	Sp	,,	,,	,,	,,	—	—	Reduced	Prec
Glucosides	,, ?	,, ?	,, ?	Sol ?	Sol ?	Sol ?	Sol ?	,, ?	—	—	,, †	Not prec
Alkaloids	,, ?	,, ?	,, ?	,, ?	,, ?	,, ?	,, ?	,, ?	—	—	—	,,
Albuminoids ..	,, ?	,, ?	,, ?	Ins	Ins	Ins	Ins	Ins ?	—	—	—	Prec
Gums	,,	Ins	Ins	,,	,,	,,	,,	Sol ?	—	—	Not reduced	,,
Pectin	,,	,,	,,	,,	,,	,,	,,	,, ?	—	—	—	,,
Pectic acid ..	Ins	,,	,,	,,	,,	,,	,,	,,	—	—	—	,,
Organic acids ..	Sol ?	Sol ?	Sol	,, ?	,, ?	,, ?	,, ?	,,	—	—	—	,, ?
Salts of org. acids	,, ?	,, ?	,, ?	,, ?	,, ?	,, ?	,, ?	,, ?	—	—	—	,, ?
Starch	Ins	Ins	Ins	,,	,,	,,	,,	Ins	—	—	—	—
Cellulose	,,	,,	,,	,,	,,	,,	,,	,,	Sol	Sol	—	—
"Para cellulose"	,,	,,	,,	,,	,,	,,	,,	,,	Ins*	,,	—	—
"Meta cellulose"	,,	,,	,,	,,	,,	,,	,,	,,	,,	,,	—	—
"Vasculose" ..	,,	,,	,,	,,	,,	,,	,,	,,	,,	Ins	—	—
"Extractives" ..	Sol	,, ?	Sol ?	,,	,,	,,	,,	Sol ?	—	—	Reduced ?	Not Prec
Colours	,, ?	,, ?	,, ?	,,	,,	,,	,,	,, ?	—	—	—	Prec

* "Para cellulose" soluble in ammonia-cupric oxide after boiling with dilute HCl.
† Glucosides reduce Fehling's solution after boiling with dilute acids; same with sucrose.
A ? shows that some marked variations or exceptions occur. Sp=sparingly soluble. Sol=soluble. Ins=insoluble.

telescope so as to alter the angular interval with which it can deal. The interval is measured by means of a grating formed by winding a fine wire round two parallel screws of very fine thread.

Mr. Shaw exhibited a modification of Weinholdt's apparatus for distilling mercury, by which a kilogramme of mercury can be distilled per hour.

Mr. Sedley Taylor exhibited a device for showing the motion of the particles of water in the transmission of a surface wave. Sixteen discs were arranged in single file, each having a white spot on its face, and on turning a handle the discs rotated so that the spots, which represented particles of water, moved so as to present a wave motion to the eye. Mr. Taylor also showed a manometric flame apparatus for exhibiting to the eye the difference of phase between two musical notes. This consisted in two bent tubes, into which the notes were sounded, and capable of being lengthened or shortened by hand like the pipes of a trombone. Opposite the ends of each of these tubes a sensitive flame was placed, and a rotating mirror showed the disturbance produced in the flames by the two different notes. A third flame exhibited the joint effect of the two notes. When the tubes were silent the images of the flames on the revolving mirror were seen as plane bands; but when notes were sounded into the tubes they became serrated, and the serrations were like or unlike, according as the phases of the notes were like or unlike.

Mr. Poynting exhibited a plan for altering the plane of polarisation of the two halves of a pencil of rays from the polariser, so that half the field may be made to appear dark when the other is bright, or both of equal brightness, at will.

Mr. Glazebrook described a method of measuring the rotation of the plane of polarisation of light by means of two spectra giving dark lines made to coincide.

Lord Rayleigh described a plan for demonstrating that yellow colour can be formed by combining red and blue together. He mixes a red solution of chromate of potash with a blue solution of litmus, and on filling it into a glass cell of a certain thickness, the light transmitted through it is seen to be yellow. Plates of glass coated with gelatin impregnated with litmus, and gelatin impregnated with chromate of potash, and placed side by side, also transmit yellow light. Lord Rayleigh finds, however, that the eyes of different persons vary considerably in their power of appreciating the tinge of the transmitted yellow; one deeming it greenish, another reddish, while a third considers it pure yellow. This peculiarity is not to be confounded with "colour blindness," since all three persons would distinguish the red and green components accurately. Lord Rayleigh also exhibited a colour-box, based on the Newtonian principle, first carried out by the late Prof. Clerk-Maxwell, but of a small size.

Sir W. Thomson then proposed a vote of thanks to Lord Rayleigh, which was seconded by Prof. W. G. Adams, and the meeting then dispersed to examine the apparatus and appointments of the Cavendish Laboratory.

CORRESPONDENCE.

AMMONIA FROM ATMOSPHERIC NITROGEN.

To the Editor of the Chemical News.

Sir,—I suppose Mr. Thompson hardly expects everyone to accept his interpretation of the two patents referred to in his note, viz., the patents of Messrs. Rickman and Thompson, and Clarke and Smith. With your permission I should like to say a word or two on the subject.

If I understand Mr. Thompson's note rightly, the gist of it is that in his opinion the process under R. and T.'s patent differs widely from that of C. and S.'s patent, and mainly on the following counts. Mr. Thompson says—

First. That the former take "N as it is in the atmosphere," and raise its temperature to that of incandescent coal.

Secondly. That they use "vapour of water," not superheated steam (S.H.S.); again necessarily at a temperature not lower than incandescent coal.

Thirdly. That they employ "incandescent coal as dust or slack," not made into bricks.

Fourthly. That they work at a "comparatively low" heat.

Mr. Thompson further asserts that ammonia and cyanides cannot be formed or exist at high temperatures. One would suppose from this that C. and S. do not take "N as it is in the air," nor use "vapour of water" nor "incandescent coke," and so forth; yet, according to their patent,—

First. They use "N as it is in the air," and raise it to the temperature of incandescent carbonaceous fuel.

Secondly. They use "vapour of water" in the form of S.H.S., and decompose it by means of an incandescent material, essentially the same as R. and T.; for it is idle to argue that "vapour of water," impinging upon an incandescent body, differs in any way from S.H.S. under similar conditions, or that the result of the reaction differs.

Thirdly. They employ "incandescent coal or coke," in conjunction with certain salts,—by preference, however, and for the sake of economy, pressed into bricks.

Fourthly. As to temperature, the expressions "comparatively low" and "intensely high" are very vague and indefinite, and depend entirely upon the circumstances of the case. It would appear, however, that the "comparatively low" heat of R. and T. is of an "intensely high" type, for they decompose their water vapour at—indeed all their reactions are necessarily carried on at, and are fundamentally based upon—a temperature not lower than that of coal in an "incandescent state," and so intensely heated as to bring about the decomposition of "water vapour"—at least this is Mr. Thompson's statement. But such a heat can only by straining the meaning of words be described as "comparatively low," and is utterly inconsistent with the actual words of their patent, viz., "a moderate heat, in a slow-burning furnace" supplied "with a small amount of air mingled with water vapour." My experience, the result of much experimental work, leads me to the conclusion that it is only at high temperatures—say from full red upwards—that atmospheric N is rendered available; whatever NH_3 is formed at low temperatures comes from the nitrogenous fuel employed, or some such analogous source; certainly not from that most inert and intractable of all chemical elements, atmospheric nitrogen.

With respect to the decomposition of cyanides and ammonia at high temperatures, which Mr. T. so positively affirms, it is well to bear in mind that the only available source of NH_3 at the present moment is the "gas liquor" resulting from the dry distillation of coals at high heats. The temperature of gas retorts ranges from full cherry-red to nearly if not quite a white heat, and the higher the heat the greater the yield of NH_3. Further, it is well known that, in the exceedingly high temperatures of iron blast-furnaces, ammonia, cyanides, and even free hydrocyanic acid, are abundantly produced; indeed the two latter have an important bearing on the actual process of reduction going on in the furnace. According to Bunsen and Playfair, who fully investigated the subject, an ordinary English blast-furnace, fed with coal as fuel, produced daily 225 lbs. of metallic cyanides, whilst the gases evolved from the furnace contained such a large amount of ammonia that the presence of that gas in the lower part (the hottest therefore) of the blast-furnace was even perceptible to the smell. They proposed to pass the gas into HCl, and thus obtain sal-ammoniac. Experiments at Alfreton Iron-Works proved that 2·44 cwts. of sal-ammoniac could be produced daily in this way. (*Vide* Wagner's "Technology," pp. 15 and 16.)

On the whole, I am inclined to think it would prove a not uninstructive experiment if Mr. Thompson would substitute a non-nitrogenous medium to decompose his water vapour, adhere to his "moderate" heat, small supply of air, &c., and note the result.

One word more. Mr. Thompson goes a little out of his way to indulge in a vein of prophetic banter, which, by the way, I rather enjoy. I think it was Punch who suggested "Don't prophesy, unless you know." I hope, without impropriety, I may recommend this maxim to the notice of Mr. Thompson. So long as he speaks of that he knows I suppose he is on tolerably safe ground, but the moment he goes beyond he is at once "up a tree," and is lost "in the clouds." I trust it will not be too startling to him to hear that an experimental furnace, some 6 or 7 feet high, that had been in pretty constant work of a severe character for some months, and which had necessarily to be removed, not only still held together, but the difficulty was to get it asunder. Considering the ordeal it had passed through it was found to have suffered little, and to be still capable of doing a very considerable amount of work.

Perhaps I ought to explain that the leading idea in Clarke and Smith's patent is to decompose water, utilising the H in the formation of NH_3, and the oxygen for oxidising purposes, notably in the production of H_2SO_4.—I am, &c.,

E. S.

May 25, 1880.

ERROR IN VAPOUR DENSITY DETERMINATIONS.

To the Editor of the Chemical News.

Sir,—I have noticed in nearly all the descriptions of Dumas' Method of Vapour Density Determinations an error, which appears not only in old books, but has been repeated in standard publications up to a recent date without, I believe, general attention having been drawn to it. It is rather remarkable that it has become so universal seeing that it is so obvious.

In making the first weighing of the globe, importance is attached to pressure and temperature observations, assuming that the weight of the vacuous globe is required, to obtain which the weight of the contained air must be subtracted. It is evident, however, that the numbers obtained in this first weighing will be the same whatever the density of the atmosphere may be, providing, of course, that both halves of the balance are similar and neglecting small variations resulting from the difference in the specific gravity of the weights and material of the globe. When, however, the globe is sealed and weighed the second time, variations of atmospheric density will cause variations of numbers obtained, because the density of the contents of the globe is now no longer at liberty to vary with the surrounding medium, and it is at this stage of the experiment only (excepting of course pressure observation at time of sealing) that the conditions of the atmosphere have to be noticed.

The only publications I remember to have noticed containing the correct method are,—"Organic Chemistry," by W. M. Watts, published by W. Collins Sons and Co., and "The New Chemistry," by J. P. Cooke Junr., published by H. S. King and Co.

In the description therein given, instead of considering the vacuous globe and making a deduction from the first weighing, a correction for buoyancy is added to the second. The results will be the same, which of the two methods he used, providing the weight of air deducted or added is governed by the temperature and pressure observed at the second weighing, though the latter is certainly more logical.

Not only have I observed that the above fallacy has occurred in nearly all publications for at least thirty years hitherto, *e.g.*, "Regnault's Chemistry," "Rose's and Fresenius' Quantitative Analysis," "Watts' Dictionary," "Deschanel's Natural Philosophy," &c.. but in one book, which is certainly an excellent and masterly treatise on the elements of organic chemistry, an unexpected and amusing statement to this effect—"To correct the volume for temperature and pressure, multiply by—

$$\frac{273 \times P \text{ m.m.}}{(273+t^\circ) \times 760} \quad \text{or} \quad \frac{273 \times 760}{(273+t^\circ) \times P \text{ m.m.}}$$

accordingly as P m.m. is greater or less than 760."

These facts suggest that whatever importance is attached by all the text-books to the determination of vapour densities, yet the actual experiment is very rarely included in the practical course of a student. Had the experiment been often repeated by students in their course of laboratory instruction, surely the directions for their guidance would have been rectified ere this.—I am, &c.,

J. Barnes.

RIVER WATER.

To the Editor of the Chemical News.

Sir,—I beg leave to supplement the abstract of my remarks on "River Water," contained in the Chemical News, vol. xli., p. 248, with some brief additional reference to their completer form.

(1.) The ratio—

$$\frac{\text{Oxygen consumed}}{\text{Sum of organic carbon and nitrogen}}$$

has the following mean values in the cases specified, viz.:—

	Ratio.
Filtered Thames	3·42
Filtered Lea	4·09
Shannon	2·74

These numbers are taken from Dr. Tidy's recent paper (*Journ. Chem. Soc.*, May, 1880). It is not, therefore, possible to calculate, from the "oxygen consumed" by any given water, how much organic matter it contains. Moreover, as Dr. Tidy's figures show, the ratio is not constant even for the same water, being sensibly higher in winter than in summer. Thus the "oxygen process," unless in special cases, furnishes us with little more than a mere suggestion.

(2.) Peaty water, if stationary and exposed to sunlight, is most undoubtedly bleached.

(3.) River waters, and especially peaty waters, contain a jelly-like constituent, which, if present in quantity, is gradually deposited on the rough surfaces or particles through which, or with which, they flow. I have myself seen peat jelly and observed its deposit. This deposition might account, in my opinion, for some part of the purification of a peaty or other water by flowing through a rough channel.

(4.) The weeds in a river's bed, into which sewage is poured, constitute a natural sewage farm, capable of absorbing chlorides, phosphates, and organic matter in the ordinary way. A great deal of the purification of the Thames must be owing to this cause, ordinarily never considered. I should regard with grave apprehension any proposal to dredge the bed of the Thames above London.—I am, &c.,

Edmund J. Mills.

Glasgow, May 31, 1880.

THE PROPOSED SOCIETY OF INDUSTRIAL CHEMISTRY.

To the Editor of the Chemical News.

Sir,—In your article (Chemical News, vol. xli., p. 243) the definition of a "Chemical Engineer" that I proposed is not quite correctly reported. Kindly allow me to put myself right.

I defined a "Chemical Engineer" to be "a person possessing chemical and mechanical knowledge, and who

applies that knowledge to the utilisation of chemical action."

To omit chemistry from the equipment of a chemical engineer seems to me, to me an old simile, like the play of *Hamlet* with Hamlet left out.—I am, &c.,

EUSTACE CAREY.

Widnes, June 1, 1880.

PROPOSED TECHNICAL SOCIETY.

To the Editor of the Chemical News.

SIR,—As a supplement to your remarks in the CHEMICAL NEWS (vol. xli., p. 243) relative to the above Society, would you kindly allow me to inform your readers of the composition of the committee and a few other matters.

The meeting held at the Owens College, Manchester, was well attended by technical chemists, from whom the following were selected to form the committee:—

Prof. Roscoe (Chairman), Mr. E. K. Muspratt (Vice-Chairman), Prof. Thorpe, Dr. Angus Smith, Dr. Campbell Brown, Dr. Hewitt, Dr. Hurter, Dr. Schunck, Mr. J. F. Allen, Mr. E. Carey, Mr. H. Crossley, Mr. A. E. Fletcher, Mr. J. C. Gamble, Mr. H. Gaskell, Mr. J. Hargreaves, Mr. W. D. Hermann, Mr. Ludwig Mond, Mr. J. L. Muspratt, Mr. Peter Spence, Mr. George E. Davis (Hon. Sec., *pro. tem.*).

The above committee was formed at the suggestion of Mr. Eustace Carey, who brought forward a proposition of Mr. Hugh Lee Pattinson for the formation of a Society of Chemical Engineers. Mr. Carey described the Society as:—

"A Society to promote the application of chemical science to manufacture, and the acquisition of that species of knowledge which constitutes the profession of a Chemical Engineer." And—

"A Chemical Engineer is a person who possesses chemical and mechanical knowledge, and who applies that knowledge to the utilisation, on a manufacturing scale, of chemical action."

From what I could gather from the speeches made at the meeting, there were many present who considered it advisable to form a Society of Chemical Engineers, though a great many were in favour of calling such a society The Society of Technical Chemists; but the majority were fairly agreed that not mere chemists were meant, but chemists with a thorough knowledge of physics combined with a fair knowledge of mechanics. Such men are not very plentiful we know, but they would, by forming such a society, help to diffuse that knowledge through the next generation, if not in the present. In the existing state of chemical industry the need of competent men to advise is becoming more and more felt, and in proof of this we have only to contrast the following processes carried out successfully by competent advisers, chemical and mechanical, with a whole host of bogus concerns, some of which, though based on sound chemical principles, have gone to the wall.

The successful processes which may be held up as examples of skill in chemical engineering are:—The Weldon Chlorine Process, the Deacon Chlorine Process, the Ammonia Soda Process, the Mond Sulphur Process, the Young Paraffin Oil Distillation, Henderson's Copper Process, Bessemer's Steel Process, Tar Distilling, Tar Colour Manufacture, and many others.

Many processes can be carried on very successfully by chemists in the laboratory, but how few are able to make chemical processes go on the large scale, and simply because they have a lack of physical and mechanical knowledge combined with their chemistry.

I am not one of those who believe that our advisers in these great matters of chemical industry should be mere thorough engineers with a smattering of chemistry, but rather that chemistry should form the central pillar and be propped up by all the collateral sciences. A little chemistry is a dangerous thing, and if we could start a new Society with men who have a thoroughly sound chemical basis, and who have also founded their experience upon the fundamental principles of mechanics, the elements of mechanism and machine construction, I am sure we should be doing much to drive out rule-of-thumb, and with it most of the quaint, expensive, and often futile, machinery which unfortunately exists in too many works of the present day.

Theoretical chemistry is well represented by the Chemical Society, trade and professional chemistry by the Institute of Chemistry and by the Society of Arts also, but a Society of Chemical Engineers would occupy entirely new ground; its field of work would be quite distinct from any of the others.

I could give many instances in which processes have failed from want of knowledge, either of physics or of mechanical principles, on the part of those who had essayed to carry them out; but, on the other hand, the chemical knowledge required was so thorough, that I am sure no mechanical or civil engineer with a mere smattering of chemistry, would have been one whit more successful.

In conclusion, I shall be glad either of the opinions or the support of technical chemists who may be interested in this matter, to lay before my committee, and I shall also be happy to give any information respecting the projected Society which I possess.—I am, &c.,

GEORGE E. DAVIS,
Hon. Sec., *pro tem.*

Dagmar Villa, Heaton Chapel,
Stockport, June 1, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 17, April 26, 1880.

The Law of Distribution according to the Altitude of the Atmospheric Substance which absorbs the Ultra-violet Solar Rays.—A. Cornu.—The mass of the absorbent matter at every altitude is proportional to the barometric pressure, and is consequently in a constant relation to the mass of the atmosphere. If the absorption of the ultra-violet rays were due exclusively to the action of the watery vapour, distributed in height according to the experimental law, the increase of the visibility of the solar spectrum would be unity (one-millionth of a millimetre) on the scale of wave-lengths for an increase in height of 286·9 metres. As direct observation shows a quantity three times larger, that is to say, a unity for 868·2 metres watery vapour, cannot be admitted as the sole cause of the absorption of these radiations. It is, on the contrary, very probable that the other elements of the atmosphere, whose proportion is regarded as constant at all heights, have the power of absorbing the highly refrangible radiations. Atmospheric dust, to which several physicists ascribe the greater part of the absorption of the ultra-violet rays, plays only a secondary part. It is very curious that watery vapour, which takes a predominant part in absorbing the less refrangible rays of the spectrum, should not behave in a corresponding manner with the more refrangible rays.

Explosive Properties of Mercury Fulminate.—MM. Berthelot and Vieille.—The authors have determined experimentally the nature of the products of the explosion of the fulminate, the quantity of heat liberated, whence its formation-heat and the measure of its explosive efficacy has been deduced, its density, and the pressure exerted during explosion in closed vessels.

On a Meteorite which fell May 10, 1879, at Estherville, Iowa.—J. Lawrence Smith.—The metallic nodules occurring in the meteorite are composed of:—

Iron	92·00
Nickel	7·10
Cobalt	0·69
Copper	trace
Phosphorus	0·112

The insoluble portion of the earthy matter contains:—

Silica	54·12
Ferrous oxide	21·05
Magnesia	24·50
Soda, with traces of potassa and lithia	0·09
Chromium oxide	traces
Alumina	0·03
	99·79

Mineralogically the meteorite is composed of bronzite, olivine, a silicate not yet determined, nickeliferous iron, chromite, and troilite.

Dependence of Two Electro-magnetic Gyroscopes submitted to the same Induction-circuit.—W. de Fonvielle.—The author concludes from his experiments that the symmetry of the attractions exerted is broken by the work of analogous reactions developed by the movement between the movable magnetisable molecules and the fixed magnetic centres, as well as between the former and the induction currents. He suggests that the theory based on the intervention of the coercitive force is insufficient for the explanation of phenomena offering such complication and capable of acting at a distance by a kind of sympathy.

Theory of Induction currents.—M. Mascart.—A mathematical paper, not susceptible of advantageous abstraction.

An Experimental Method for Determining the Lines of Level in the Stationary Efflux of Electricity along Conducting Surfaces.—A. Guebhard.—This paper requires the four accompanying diagrams.

Absolute Measurement of Peltier's Phenomenon on the Contact of a Metal with its Solution.—E. Bouty.—This paper does not admit of useful abstraction.

Measurement of the Difference of the Potential of Two Metals in Contact.—H. Pellat.—The author has investigated the changes which the cifference of potential undergoes in regard to the physical state of the metallic surfaces. He has also studied the influence of a change of temperature, and of the gases surrounding the plates.

The Theory of Circular Double Refraction.—M. Gouy.—The phenomenon discovered by Fresnel is only a necessary consequence of rotatory double polarisation. The remarkable splitting-up, which, according to Fresnel's ideas, is a double refraction, becomes, if viewed with reference to the facts themselves, a phenomenon of diffraction of a peculiar kind.

Influence of Temperature on the Compressibility of Gases under High Pressures.—E. H. Amagat.—The following laws are proposed:—(1.) When a gas is more compressible than Mariotte's law indicates, its compressibility increases with a rising temperature. (2.) When a gas is less compressible than the law indicates its compressibility grows with the temperature. (3.) This increase, very rapid in the neighbourhood of the least ordinate where the gas follows accidentally the law of Mariotte, quickly slackens, so that under constant pressures the effect of temperature becomes less and less considerable.

Researches on the Passivity of Iron (Second memoir).—L. Varenne.—The determination of passivity is always preceded by chemical action of variable duration. The passivity of a rod of iron may be occasioned by the immersion of a part only in concentrated nitric acid. Passivity may be produced by the prolonged exposure of iron to nitric oxide under strong pressure.

Proportion of Iron in the Mineral Waters of Rouen and of Forges-les-Eaux.—A. Houzeau.—The author's method is to mix a known volume of the water, immediately after being drawn at the spring, with pure sulphuric acid, evaporate to dryness, and expel all the excess of acid, treat the saline or carbonaceous residue with pure hydrochloric acid, bring the iron to the ferrous condition with pure metallic zinc, and titrate with permanganate.

Isomers of Phloro-glucine.—A. Gautier.—The author asks if the glucoses are apt to furnish phloroglucine by simple dehydration, and if distinct phloroglucines correspond to the various glucoses which enter into the composition of the vegetable glucosides. He has specially examined the aromatic sugar of the colouring-matter of Carignane wine, $C_{24}H_{20}O_{10}$, the aromatic sugar derived from quercitine, and that obtained by the oxidation of phenol.

The Products Contained in the Coke of Petroleum.—L. Prunier and E. Varenne.—The authors admit the presence in the coke of petroleum of a complex totality derived from a pyrogenous equilibrium (see *Comptes Rendus*, 88, p. 386).

A Singular Explosion Produced during the Heating of Wine, and a New Method for the Determination of Alcohol.—V. Wartha.—A quantity of Tokay wine, about 6 hectolitres, containing 15 per cent of alcohol by volume, was being submitted to Pasteur's process. When almost all the wine had passed through the apparatus, a violent explosion took place, shattering the staves of the cask to fragments. It is supposed to have been caused by the ignition of a mixture of alcoholic vapour and atmospheric air contained in the empty part of the cask. He considers that if wine is heated to 70°, the vapours may reach the dangerous limit of 43° (the "flashing-point"), and that when Pasteurising strong wines they should be refrigerated with ice as they flow from the apparatus. The method for the determination of alcohol is not described.

Synthetic Reproduction of Aluminous Silicates and Alkaline Alumino-silicates.—S. Meunier.—The author describes his methods and results at considerable length.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.
No. 75, March, 1880.

Report Presented by M. Aimé Girard on M. Olivier Lecq's Apparatus for the Analysis of Beet-roots.—The description of the apparatus cannot be usefully reproduced without the ten accompanying figures.

The French Patent Law.—Ch. de Laboulaye.—The writer argues in favour of a preliminary examination of applications for patents, such as is practised in America and in Germany.

Chemiker Zeitung.
No. 9, February 26, 1880.

Determination of Thein.—C. Patrouillard.—The author digests 15 grms. tea with boiling water to complete exhaustion. The aqueous extracts, united and filtered, are evaporated to dryness, with the addition, towards the last, of 2 grms. calcined magnesia, and 5 grms. of powdered glass. The residue is finely pulverised and digested with ether in a flask for twenty-four hours with occasional agitation. Fresh ether is continually substituted as long as anything is taken up. The united ethereal extracts are distilled, the crystals of thein redissolved in a little chloroform, and the solution evaporated in a tared capsule. The proportion of thein in tea which has not been treated with water ranges from 1 to 3½ per cent.—*Repertoire Pharm.*

Qualitative Separation of Copper, Bismuth, and Cadmium.—M. Iles.—To the slightly acid solution of the three metals, potassium ferricyanide is added in slight excess, when all three are thrown down as ferricyanides. Potassium cyanide is added in excess and the mixture is gently heated. The copper and cadmium compounds dissolve, whilst the bismuth remains as a white flocculent hydroxide. The filtrate is divided into two portions ; the one is tested for copper with hydrochloric acid, which occasions a brown-red precipitate of copper ferrocyanide, whilst to the other is added a little ammonia and ammonium sulphide. On the application of a gentle heat, yellow cadmium sulphide is precipitated.—*Pharm. Zeitung*

New Process for Bleaching Vegetable Fibres.—O. Bayle and R. Pontiggia add to a basic bath of alkali and chloride of lime, margaric, stearic, or oleic acids, or the mucilage of flax, or of Panama bark. This addition is said to limit the destructive action of the chloride, and promote the solution of the gummy and resinous matters which adhere to the raw fibre.—*Färb. Zeitung.*

Petroleum and Coal Benzines.—The crude petroleum, after treatment with sulphuric acid, is fractionated into naphtha, refined petroleum, and petroleum grounds. The naphtha, which forms from 5 to 10 per cent of the products, is limpid and mobile, boiling at from 50° to 150°, and having the sp. gr. 0·65 to 0·72. It is again fractionated. The most volatile portion is petroleum ether, boiling at 40° to 70°, and having the sp. gr. 0·64 to 0·65. It serves for dissolving fatty matters. The second portion, which distils from 65° to 90°, is gasoline, used for the production of gasoline gas. Petroleum benzine, the third portion, passes over between 90° and 110°, and serves as a solvent. The residue in the still is known as turpentine-substitute.

Turkey-red Oil, Soluble in Water.—To 3 kilos. castor oil are added, with constant stirring and in a very thin gradual stream, 650 grms. sulphuric acid at 66° B. A rise of temperature must be carefully avoided. The whole is let stand for twelve hours, diluted with 3½ kilos. water, and soda-ash added in small quantities (about 650 grms.) till the mixture no longer reddens litmus. To dissolve the white emulsion thus obtained ammonia is added till a portion dissolves in distilled water. It is then allowed to settle, and the clear liquid drawn off for use. Sodium sulphate is found in crystals at the bottom.—*Schweiz. Gew. Bl.*

New Process for the Manufacture of Sulphuric Acid.—A. Houzé.—The author mixes sulphurous acid with steam and superheated air. The temperature must not reach that at which sulphuric acid is decomposed. The condensation is carried on in stoneware vessels.

No. 10, 1880.

This issue contains nothing suitable for abstraction.

No. 11, 1880.

This number contains a very long original article by O. Cordel on the manufacture of animal charcoal.

Chemisches Central-blatt.
No. 11, March 17, 1880.

Agreement of the Oxygen-stere, 5·4, with the Stere of Chlorine, Bromine, and Iodine.—H. Schröder.—After the author had explained by a number of examples the idea of the "volume proportion" or stere, and the fact that in the solid as well as in the gaseous state, the elements combine only in whole volumes, *i.e.*, in volumes which bear to each other the proportions of simple integral numbers, he pointed out that he had assigned the stere 5·4 both to oxygen and to the halogens. He considers that the volumes of these bodies in their solid state, as well as the behaviour of their vapours at high temperatures, seem to indicate that chlorine, bromine, and iodine are probably oxygenous bodies.—*Tageblatt des Natur. Vereins Baden-Baden*, 1879, 191.

Behaviour of Sulphuretted Hydrogen with the Salts of Heavy Metals.—M. Dellfs.

Annales de la Société des Sciences Industrielles de Lyon.
No. 4, 1879.

This number contains no chemical matter.

NOTES AND QUERIES.

Extracts of Dyewoods.—Can any reader refer me to a full description of the methods used in this country and on the Continent for preparing extracts of dyewoods, with details of the apparatus, and an account of the composition of the extracts produced? Or where can I find any part of this information.—A CONSTANT READER.

MEETINGS FOR THE WEEK.

MONDAY, 7th.—Royal Institution, 5. General Monthly Meeting.
TUESDAY, 8th.—Photographic, 8
—— Royal Medical and Chirurgical, 8.30.
WEDNESDAY, 9th—Geological, 8.
—— Microscopical, 8.
THURSDAY, 10th.—Royal, 4.30.
—— Royal Society Club, 6.30.
FRIDAY, 11th.—Quekett, 8.
Astronomical, 8.
SATURDAY, 12th.—Physical, 3.

TO CORRESPONDENTS.

Alex. M'Ivor.—Consult any standard work on quantitative analysis.
H. Rayner.—Information asked for through our columns is intended to be made public for the benefit of all thereaders of the CHEMICAL NEWS.

THE JOURNAL OF SCIENCE
for June (Price 1s. 6d.), includes—
Insanity and its Difficulties.
The History of Antozone and Peroxide of Hydrogen. By Albert R. Leeds, Ph.D.
The Origin of Falling Motion. By Charles Morris.
The Aurora.
Flighty Aspirations. By Fred. W. Brearey, Hon. Secretary to the A.S.G.B.
Analyses of Books. Correspondence. Notes.
London: 3, Horse-Shoe Court, Ludgate Hill.

INSTITUTE OF CHEMISTRY.

PRIZES.—DR. FRANKLAND has offered a Prize of £50 for the best Original Investigations involving GAS ANALYSIS; and Dr. C. MEYMOTT TIDY has also offered a Prize of £25 for the best Original Investigation on SPECIAL REACTIONS OF THE ALKALOIDS, AND THEIR SEPARATION FROM ORGANIC MIXTURES. These Prizes will be open to Associates, and to all persons (except Fellows of the Institute) who shall, before the 31st December next, have qualified for the Associateship in all respects short of passing the prescribed practical Examination, and successful competition for these Prizes will be accepted in lieu of such practical Examination. Further information may be obtained on application to the Secretary, Mr. C. E. GROVES, Somerset House Terrace, W.C.

DENTAL HOSPITAL OF LONDON,
Leicester Square (President, H.R.H. the Duke of Cambridge, K.G.), and THE LONDON SCHOOL OF DENTAL SURGERY. The Posts of Lecturer on Metallurgy and on Mechanical Dentistry at the above School are vacant. Candidates for the appointments are requested to send in their applications to the Honorary Secretary, at the Hospital, on or before July 1st next. The Candidates for the post of Lecturer on Mechanical Dentistry must hold the Dental Diploma of the Royal College of Surgeons of England.

C. H. GIMINGHAM'S PATENT COMBINATION BLOWPIPE,
FOR AMATEUR & PROFESSIONAL GLASS-BLOWING, &c.
AS USED IN L. CASELLA'S WORKSHOPS.

The difficulties of Glass-Blowing are reduced to a minimum by this instrument. It combines the use of the large or small flame and large Bunsen flame, the changes from one to the other being made in less than one second.
SOLE MAKER—
L. CASELLA, 147, HOLBORN BARS, LONDON, E.C.

ESTABLISHED 1798.

ROBERT DAGLISH & CO.,
ENGINEERS, BOILER AND BRIDGE MAKERS, MILLWRIGHTS,
BRASS AND IRON FOUNDERS.

Manufacturers of every description of Condensing, or High-pressure Blowing, Pumping, Rolling, Winding, and Patent Steam-engines, of any required power, for Irrigating, Draining, Mining, Rolling Mills, or Water Works purposes, and Manufacturers of every description of Chemical, Colliery, Copper Ore, Gold Mining, Glass, and Rock-salt Machinery.
Black-ash Revolving Furnaces of the Most Approved Type.
Bessemer Steel-Rail Plant.
Compressing-Engines for Collieries, Iron Works, and Weldon Patent Bleaching-Powder Process.
Caustic, Chlorate, Decomposing, Nitre, Nitro-Glycerine, Iodine Potash, Sulphur, Acid, and Oxalic Pans.
Gas Producers Patent for Heating and other Purposes.
Pyrites Burners for Irish, Norwegian, and Spanish Ores of Improved Construction.
Patent Rousing Machinery for Brewers.
Retorts, Acid, Gas, Iodine, Nitric, Nitre, Nitro-Glycerine and Vitriol Refining.
Steam Superheaters improved for Oil, Tar, and Resin Refining.
Steam Sulphur Melter.
Stills for Oil, Resin, and Tar.
Wheels, Bevel, Mitre, and Spur Moulded on the Shortest Notice by Patent Machinery.
Makers of Mactear's Patent Carbonating Furnace, Jones and Walsh's Patent Sulphate of Soda Furnace, Parnell and Simpson's Patent Causticiser, and Kynaston's Patent Alum Plant.

Lists sent on Application.

Photographs, Plans, and other information supplied on receipt of Order.

ST HELEN'S ENGINE, BOILER, AND BRIDGE WORKS AND FOUNDRY,
LANCASHIRE.

BISULPHIDE OF CARBON,
CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,
161 162 163, PALMERSTON BUILDINGS, LONDON, E.C.

THOMAS ADKINS & CO.,
SMETHWICK,
NEAR BIRMINGHAM

MANUFACTURERS OF SPECIALLY PREPARED RED LEAD FOR FLINT-GLASS MAKING.

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

JESSE FISHER & SON,
Phœnix Chemical Works Ironbridge.

CHEMICAL & PHYSICAL APPARATUS,
BOTTLES, PURE CHEMICALS,
REAGENTS, STANDARD SOLUTIONS,
And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

MOTTERSHEAD & CO.,
7, Exchange Street and 10, Half Moon Street,
MANCHESTER.

TOWNSON & MERCER,
89, Bishopsgate Street Within,
LONDON.

Wholesale and Export Dealers and Manufacturers of
CHEMICAL & SCIENTIFIC APPARATUS
PURE CHEMICALS, &c.,
For Analysis and the general Laboratory Use of Manufacturers and Professors of Universities, Schools, Mines, &c.

Now ready,
TOWNSON & MERCER'S COMPLETE CATALOGUE
Chemical and Scientific Instruments, Pure Chemicals &c. Demy 8vo. Illustrated with upwards of 800 Woodcuts. Price 2s. 6d post free.

GREENBANK ALKALI WORKS COMPANY
(LIMITED),
ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{2}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{10000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

DAHL & CO.,
BARMEN (RHENISH PRUSSIA),
MANUFACTURERS OF
ANILINE AND NAPHTHALINE COLOURS.
SPECIALITY—Ponceau Naphthol-Reds as a Substitute for Cochineal.
Sole Agency and Depôt in England,
THEODOR BANG,
BENSON'S BUILDINGS, BASINGHALL ST., LEEDS.

THE CHEMICAL NEWS.

VOL. XLI. No. 1073.

OBSERVATIONS UPON DR. TIDY'S PAPER ON RIVER WATER.

By R. WARINGTON.

As the time available for the discussion of Dr. Tidy's recent paper at the Chemical Society proved quite insufficient for a full consideration of the many important questions raised in that communication, I may perhaps be allowed to make a few remarks on some aspects of the subject in the pages of the CHEMICAL NEWS.

Both in Dr. Tidy's paper, and in the discussion which followed, it was remarkable that the destruction of sewage in river water was in every case referred to the oxidising influence of the air. Dr. Tidy, who contended that sewage was destroyed in the course of a river's flow, spoke of that sewage as being destroyed by contact with atmospheric oxygen; while Dr. Frankland, who held that this destruction of sewage took place to a very limited extent, supported his argument by experiments in which diluted urine or sewage was found to be tolerably permanent when agitated with air. Now, if we are to take an exact view of this important question, we must surely bear in mind that modern investigations plainly teach us that in nature organic matter is resolved into inorganic matter not by mere contact with atmospheric oxygen, but by the agency of organic life. Such organic fluids as urine and milk have been repeatedly shown to be capable of preservation through long periods, in free contact with air, if only all germs of organic life be excluded. We cannot for a moment suppose that Drs. Tidy and Frankland were not well acquainted with these facts, but the idea of the primary importance of organic life for the destruction of sewage has certainly been strangely absent in their discussion of the question.

The decay of organic matter is the joint work of a number of independent organisms of different functions, the action of one class following that of another, and carrying the process through a further stage. We are too imperfectly acquainted with the organisms effecting these changes, and their particular functions have been too little studied, for any accurate sketch of these processes to be given. In the first rank we must probably place the fungi, whose main function is apparently the rapid oxidation of carbon. Following these we have the innumerable army of bacteria, embracing many families of very similar physical structure, but endowed with very different chemical powers. One class of these bacteria attacks nitrogenous organic matter, and liberates the nitrogen in the form of ammonia; while another class of bacteria determines the conversion of carbonaceous organic matter and ammonia into simple inorganic bodies—carbonic and nitric acids. Lastly, we have the chlorophyll-bearing plants, which consume the carbonic acid, ammonia, and nitric acid produced by lower organisms, and are also capable of assimilating urea and other amide bodies, and a large number of inorganic ash constituents.

For organic matter to be destroyed it is necessary that these organisms should exercise their functions in a certain order. The nitrification bacteria would produce no nitric acid in a mass of fresh nitrogenous matter; the fungi and the putrefaction bacteria must first run their course and prepare the way for the nitrifying organism. In the same way green vegetation is impossible till every stage of putrefactive change is completed.

The bearing of these ideas on the question of the destruction of sewage in river water is obvious. That sewage will finally be destroyed in a normal river of adequate temperature and sufficient length surely admits of no doubt. It is only when the natural agents of oxidation are excluded by addition to the water of chemical refuse fatal to organic life, or when vegetation is prevented by artificial means, that the conditions necessary for purification are absent. The practical question whether in any particular stream the sewage has been efficiently destroyed can, however, only be determined by an actual examination of the water; and we must admit, apart from any analysis, that the condition of our principal rivers is certainly unfavourable for complete purification, seeing the vast quantity of sewage introduced within comparatively short distances of their outfall, and the artificial character of the streams maintained for the purposes of navigation.

The conditions of laboratory experiments cannot easily be made comparable with those of a natural river, if organic life rather than mere exposure to air is the true agent in the destruction of sewage. In any experiments it would seem advisable to employ natural river water and not an artificial mixture, as the needed organisms would more probably occur in the natural fluid. In such a mixture as that of fresh urine with deep well-water it is obvious that organisms have been as far as possible excluded. When working with any recent dilution of sewage, time must always be given for the multiplication of the organisms before any appreciable effect can be expected from their action. A solution seeded with a small quantity of the nitrifying bacteria will remain for many days without any apparent change; but after a while nitrification commences, and proceeds from day to day at an accelerating rate.

If the oxidation of sewage is effected by living organisms, temperature and light become important factors in the process. It may truly be said that the activity of bacteria is a function of temperature. It is a very familiar fact that at a low temperature no putrefactive change will take place. As the temperature rises the activity of the putrefaction bacteria rapidly increases; it reaches a maximum at a tropical summer heat, and then gradually diminishes to nothing as the temperature approaches 60° C. In the case of the nitrification bacteria, Schlœsing and Müntz have shown that nitrification is ten times more rapid at 37° than at 14°. An example of the little weight hitherto attached to the action of these low organisms was afforded by Dr. Frankland's remark at the Chemical Society that it was "a curious thing" that the oxidation of organic matter in the Irwell river was shown by his experiments to be far more rapid at 17° than at 12°; if the oxidation in question was the work of bacteria the increased rapidity of action with a rise in temperature would be only what we should expect. The influence of light must also not be forgotten. Both the putrefaction and nitrification bacteria flourish best in darkness; a turbid polluted stream is thus apparently a better field for the activity of such low organisms than any small bulk of fluid exposed to light in a laboratory.

I am unable to understand on what grounds Dr. Tidy has placed fish among the purifying agents of river water. As they cannot exist in the most polluted part of the stream, it is difficult to imagine that they consume any of the solid organic matter brought down by the sewage, as this must surely have been deposited, or become far advanced in decomposition, before the cleaner portion of the river is reached in which fish exist. The respiration of the fish must also necessarily diminish the amount of oxygen in the water. Lower forms of animal life, inhabiting the mud of the river, are probably efficient scavengers of solid matter, and become themselves in turn the food of fish.

Turning, now, for a moment to the question of the removal of peaty matter from water, it may perhaps be of service to remind those working on the subject that humic acid is stated by Detmer to be a colloid body, and that it forms insoluble compounds with lime and ferric oxide. Apocrenic acid is according to the same investigator a diffusible substance, and capable of being assimilated by plants.

A large part of the interest belonging to Dr. Tidy's

paper is connected with those alterations in the composition of river water, which he shows to occur regularly in the course of the year. In the case of Thames and Lea water a maximum contents of dissolved solid matter is found in February; this amount regularly diminishes till a minimum contents is reached in August, or, in the case of the Lea, in September. As a rule every constituent of the solid matter participates in this rise and fall, with the single exception of the chlorine, which is on the whole rather greater in the summer months when the other constituents are near their minimum. No cause is suggested in Dr. Tidy's paper for this regular alteration in composition, and the question was for want of time left undiscussed at the Chemical Society.

It is difficult to imagine that these regular changes in composition are determined by differing amounts of flood water. The months of March and April are certainly not months in which floods are common, yet they lie quite near to the period of maximum impurity; nor is it easy to imagine that floods commence in the Thames as early as September, though in this month the impurities begin distinctly to rise. The times of maximum and minimum impurity are, on the other hand, in close accordance with the alteration of the temperature of the water, the maximum impurity following hard on the minimum temperature of the river, and the minimum impurity succeeding closely the maximum temperature. This fact seems to suggest that the alteration in composition is chiefly brought about by the organic life in the water. When the water is at its coldest, all forms of life are most inactive, and the water at this period possesses its greatest impurity. As spring advances life awakes, and the water becomes purer month by month, reaching a maximum degree of purity in August or September, a natural result of the accumulated effect of active life during the summer months. After this point, life rapidly diminishes in activity, and the water as rapidly returns to its winter composition.

The effects of life on the composition of water are twofold, direct and indirect. In pure waters the indirect influence of green submerged vegetation may be very considerable. My father made monthly determinations for some years of the hardness of the water of a fresh-water aquarium standing in the window of his sitting-room. The aquarium contained *Vallisneria* and fish; the water was never changed. The result of seventeen months' observations will be found in the *Proceedings of the Royal Society*, 1868, 189. The hardness in the water in this aquarium was 12·5° in July, 1861, from which point it gradually rose to 25° in the following February, then slowly sank to 12° in August, after which it again commenced to rise. The maximum hardness was thus in February, and the minimum in July or August. The cause of this change was clearly due to the consumption of the carbonic acid dissolved in the water by the green vegetation during the months of greatest light and heat. This removal of carbonic acid from the water determined a precipitation of carbonate of calcium on the glass sides of the aquarium, and the water in consequence diminished in hardness. As the supply of light and heat diminished the carbonic acid furnished by the respiration of the fish gradually overbalanced the amount decomposed by the plant, and the carbonate of calcium was re-dissolved.

It is evident that an effect of the kind just stated affects only the temporary hardness of a water. The analyses of Lea water given by Dr. Tidy show a marked maximum of temporary hardness in February, and a considerable diminution during the summer months; but the rise and fall are not regular. With the Thames water there is little indication of such a change as that just described. A reason, however, is at once afforded by the fact recorded by Dr. Tidy on page 274, that Thames water contains more carbonic acid dissolved in it in summer than in winter. Under these circumstances we can therefore expect no diminution in the temporary hardness.

The direct influence of vegetation on the water in which it exists is to remove from it the materials necessary for plant growth, these constituents afterwards passing in many cases into the bodies of animals which feed on the vegetation. It is to this direct action of vegetation that the changes in the inorganic constituents of river water are most probably due. The nitrates, sulphates, and all the ash constituents necessary for plant tissue diminish as the season advances, being taken up by the actively growing vegetation, while the chlorides—which are well known to agricultural chemists as unessential to plant life—remain untouched, or indeed somewhat increase, from the concentration of the water during the heat of summer. As autumn sets in, not only does the taking up of matter by the plant cease, but the plants on decay restore to the river more or less of the constituents previously removed. All the changes from maximum to minimum are more marked in the Lea than in the Thames, the former river having probably a greater proportion of vegetation in relation to its volume of water.

It remains to glance, in conclusion, at the diminution of organic carbon and nitrogen in river water during the summer months. This seems probably due to the action of the bacteria, which becomes intensified as the temperature of the water rises. Dr. Tidy's gas analyses, already referred to, show that in Thames water the dissolved oxygen is greatly diminished during the summer months while the carbonic acid increased, a result, doubtless, of the more rapid oxidation then in progress.

ON THE INFLUENCE OF SUPERFUSION ON THE MOLECULAR ARRANGEMENT OF CUPELLED GOLD.

By Dr. A. D. VAN RIEMSDIJK,
Assayer-General of the Netherlands Mint.

As an appendix to my research on "Flashing"* it remains for me to mention the remarkable influence of superfusion on the physical state, or rather the molecular arrangement of cupelled gold. The abrupt and sudden change of state marked by the flashing, which puts an end to the abnormal condition of the superfused metallic mass, produces without exception a button of solidified gold, possessing in the highest degree the softness, the ductility and the malleability which characterise the chemically pure metal. A button of cupelled gold which has flashed, if flattened with the hammer upon a steel anvil, forms a disk with a perfectly regular outline, without the least crack. On passing this disk several times through the laminating rollers we obtain a slender fillet which preserves its entire malleability: the circumference of this fillet is perfectly regular.

But the case is very different if the superfusion is prevented, either by contact with a fragment of solid gold before the liquid button has cooled down to the normal point of solidification, or by the previous admixture of traces of iridium, osmium-iridium, &c. Cupelled gold which solidifies without flashing, *i.e.*, in the ordinary manner, gradually losing the latent heat of fusion, presents under the hammer or the rollers a metal more or less brittle. The disk and the band offer irregular outlines, cracked in several places.

The cause of this non-malleability should be attributed to a slight proportion of lead (about 0·7 mill.), which cupellation, even at a strong heat, has not been able to separate from the gold which has been passed through the assay furnace. With bismuth the same results are obtained. Pure gold, cupelled with bismuth in excess, retains always traces of this metal, which considerably diminish the malleability of the button if its superfusion has been hindered. On the other hand, cupelled bismuthiferous gold which has "flashed" is perfectly soft and malleable.

* Chemical News, vol, xli., p. 126

The classic researches of Charles Hatchett,* executed at London at the beginning of this century, have shown us the injurious influence of several metals added to gold, whether pure or alloyed, even in very limited quantities. It appears from these researches that a proportion of lead or bismuth of 1 part in 1920 = 0·521 mill., is enough to destroy the malleability and the ductility of gold. According to our own researches this is perfectly correct, in the case when gold, mixed in the liquid state with a little Pb or Bi, sets according to the ordinary laws of solidification. But if the metal has undergone superfusion, "flashing" before becoming solid, this anomalous change of condition completely destroys the injurious influence of the lead or bismuth which remains in the cupelled gold.

It is proper here to remark that in gold, pure or alloyed (with copper or cupriferous silver), which has not been submitted to cupellation with Pb or Bi, the manner of solidification has no influence on the physical condition of the metal in the solid state, the great malleability of which is retained under all conditions. What is true as regards pure gold or cupriferous gold cupelled with lead, holds equally good for its alloy with cupriferous silver,—*e.g.*, for an ordinary assay at the standard of 0·900, composed of 250 Au, 25 Cu, and 625 Ag. If the cupelled alloy, when taken from the furnace in the liquid state, has "flashed" before setting, the button of the plumbiferous alloy behaves perfectly under the hammer and the roller; it is malleable in all respects. If, on the contrary, superfusion has been prevented, and the button has set gradually without "flashing," we obtain a brittle metal, which yields a band irregular in outline and often cracked, the prominences of which are easily detached from the bulk of the band, and may occasion a mechanical loss in the cornet. It is evident that the phenomena of superfusion and of flashing observed in assay-buttons augment remarkably our confidence in the standard found, since they produce intact bands and cornets free from all cracks; on the other hand, all the causes which annul superfusion, and consequently "flashing," detract from the exactness of the method of assay generally practised.

There is an effectual method for restoring complete malleability to gold cupelled with lead or bismuth, and which has set without "flashing." It is merely necessary to re-melt it in a new cupel in the assay furnace, and to add to the liquid metal chloride of copper, $CuCl_2+2H_2O$, about 50 m.grms. wrapped in a bit of paper, to ½ grm. of gold. During the very brisk and short reaction between the copper chloride and the gold contaminated with Pb or Bi,—which is characterised by a brilliant blue flame,—these latter metals are completely eliminated in the form of volatile chlorides. The purified gold, taken from the furnace in a liquid state, sets without flashing, and forms a button of perfect malleability.

The copper chloride process may serve to show that a slight proportion of iridium does not appreciably interfere with the malleability of gold. If we submit to cupellation ½ grm. of pure gold mixed with 5 m.grms. of finely-divided iridium, we obtain a button which sets without presenting the phenomena of superfusion and of flashing, and constitutes a metal brittle under the hammer and the rollers. But this defect in malleability may be completely removed by contact with copper chloride after having melted the cupelled gold a second time in the assay furnace. It is easy to prove that in this operation the iridium resists, if not entirely, at least mainly, the action of the copper chloride; for iridiferous gold which has been submitted to fusion with this chloride, if returned to the cupel with excess of lead, sets immediately after being withdrawn from the muffle in the liquid state. Superfusion and consequently "flashing" are prevented by the traces of iridium which the copper chloride has not been able to separate from the button.

The same facts are observed on the addition of small traces of iridium or of osmium-iridium to pure gold in a state of fusion, without calling in the intervention of lead to effect the mixture. Iridiferous gold, prepared by a direct method, preserves its malleability.

But it must be admitted with reason that the presence of iridium, osmium-iridium, &c.,—that is to say, of metals of the platinum group which are not capable of forming a homogeneous alloy with the gold in which they are mixed,—destroys in part its continuity, and therefore its ductility, properties which characterise gold when pure or alloyed with copper or with cupriferous silver.

* *Phil. Trans. of the Royal Society of London for the year* 1803 Part 1, p. 43.

A METHOD FOR THE PROXIMATE ANALYSIS OF PLANTS.*

By HENRY B. PARSONS.

(Concluded from page 258.)

VI. *Estimation of Eighty per cent Alcohol Extract.*

That part of the plant not dissolved by benzole should be dried at 100° C., and then completely exhausted by eighty per cent alcohol (specific gravity 0·8483 at 15·6° C.). This requires from twelve to fourteen hours' continuous treatment with the solvent. Remove, dry, and weigh any crystals or powder that may separate upon concentrating and cooling the alcoholic percolate. Make the clear liquid to a definite volume by adding more eighty per cent alcohol. In an aliquot part of this liquid determine *total organic matter* and *ash:* in another equal portion determine *total organic matter* and *ash soluble in water*, and, by difference, *total organic matter insoluble in water.*

The remaining clear alcoholic liquid should be evaporated carefully to dryness, pulverised, and treated with several considerable portions of absolute alcohol (specific gravity 0·7938 at 15·6° C.).

A. Soluble in Absolute Alcohol.

a. Soluble in water.

a 1. *Precipitated by subacetate of lead.*
Tannin and most organic acids; some extractives; some inorganic acids of the ash. Weigh in Gooch's filter, ignite cautiously, and again weigh; loss equals organic matter precipitated.

a 2. *Not precipitated by subacetate of lead.*
Alkaloids, glucosides, some extractives and colours. Determine by difference between *a* and *a* 1.

b. Insoluble in water.

b 1. *Soluble in dilute hydrochloric acid.*
Alkoloids, glucosides, (rarely) some extractives. Determine by difference between *b* and *b* 2.

b 2. *Insoluble in dilute hydrochloric acid.*

b 3. *Soluble in dilute ammonic hydrate.*
Most acid resins, some colours. Determine by difference between *b* 2 and *b* 4.

b 4. *Insoluble in dilute ammonic hydrate.*
Neutral resins, some colours, albuminoids (in some seeds). Re-dissolve in alcohol, evaporate and weigh.

B. Insoluble in Absolute Alcohol.

c. Soluble in water.

c 1. *Precipitated by subacetate of lead.*
Some colours, extractives, albuminoids (rarely), organic acids and inorganic acids of the ash. Weigh in Gooch's filter, ignite cautiously, and again weigh; loss equals organic matter precipitated.

c 2. *Not precipitated by subacetate of lead.*
Alkaloids, glucosides, sucrose, glucose, some extractives. Determine by difference between *c*

* From the *American Chemical Journal*, vol. i., No. 6.

and *c* 1. Remove Pb by H_2S, H_2SO_4, Na_2CO_3, or other means, and titrate for sucrose and glucose.

d. Insoluble in water.

d 1. *Soluble in dilute hydrochloric acid.* Some alkaloids and glucosides. Determine by difference between *d* and *d* 2.

d 2. *Insoluble in dilute hydrochloric acid.* Few resins, some extractives, and colour substances. Dissolve in alcohol, evaporate and weigh in a tared dish.

In some cases it may be preferable to use the following method for analysis of the eighty per cent alcohol extract; it is more desirable when the plant examined contains a considerable amount of sugars, tannic acid, &c.,

Alcohol Extract, dilute to 200 c.c. with eighty per cent alcohol.

1. In 20 c.c. determine *total organic matter* and *ash*.

2. In 20 c.c. determine *total organic matter* and *ash* that are *soluble in water*, and, by difference, *total organic matter insoluble in water*.

3. Evaporate the remaining 160 c.c. to dryness, treat with water, filter, and make the filtrate measure 160 c.c. Reserve the insoluble matter on the filter for examination. (10).

4. In 20 c.c. of the aqueous solution determine tannin gravimetrically by A. Carpeni's method;* precipitate by ammoniacal acetate of zinc, use a Gooch's filter, wash the precipitate with very weak ammonia, dry at 120° C., weigh, ignite cautiously, again weigh. The loss by ignition equals tannic acid, in absence of certain interfering substances.

5. Precipitate 20 c.c. by normal acetate of lead, and determine, as before described, the amount of organic matter after drying at 100—120° C. This precipitate will contain, if the substances are present in the plant, *tannic, gallic*, and most other *organic acids*, some *colours*, rarely *albuminous substances*, some *extractives*, and most *inorganic acids* of the ash. Determine, by difference, the amount not precipitated by this treatment.

6. In 20 c.c. determine in like manner the amount precipitated by basic acetate ("subacetate") of lead. This reagent precipitates a greater number of acids, colours, and extractives than are precipitated by the normal acetate; hence it is frequently possible to estimate such substances by subtracting the amount precipitated by one reagent from the amount precipitated by the other. To the filtrate add a slight excess of dilute hydrochloric acid, boil gently for half an hour, and determine in the liquid *total glucose* by use of Fehling's solution.

7. Precipitate 20 c.c. by subacetate exactly as in 6, and use the precipitate as a duplicate to check the amount there estimated. To the filtrate add a very slight excess of solution of carbonate of sodium, filter from the carbonate of lead, wash well with water containing a little alcohol, and in the filtrate estimate *actual glucose*. If the glucose thus found is appreciably less than that in 6, subtract it from that amount; this glucose may be due to the presence in the plant of *sucrose* or some *glucoside*. If due to sucrose, the amount of the latter may be found by multiplying this residual glucose by 0·95; if to a glucoside, a fit subject for an extended investigation is presented. The properties, formula, and decomposition products of the newly-found glucoside should be carefully studied.

8. Precipitate 20 c.c. with subacetate of lead, as in 6 and 7, employing the precipitate as material from which to separate organic acids, after removal of lead by sulphuretted hydrogen. Acidulate the filtrate with sulphuric acid, add an equal volume of alcohol, allow to stand two hours, filter, wash the precipitate with fifty per cent alcohol, and evaporate the filtrate until all alcohol has been dissipated. Test the acid solution for *alkaloids, glucosides, sugars, extractives*.

9. Reserve the remaining 40 c.c. for duplicating any unsatisfactory determinations.

10. The residue mentioned in 3 as insoluble in water may contain *resins, albuminoids* (especially from seeds), *colours, alkaloids, glucosides*. Dilute acids remove *alkaloids* and some *glucosides*, dilute ammonic hydrate will remove some *resins, colours*, and *glucosides*. Any still insoluble residue probably contains *albuminous* or *resinous* substances.

VII. *Estimation of Cold Water Extract.*

That part of the plant remaining insoluble after treatment with alcohol should be dried at 110° C. and completely extracted by cold water. When the plant contains considerable mucilaginous matter, this is best removed by placing the substance in a flask or graduated cylinder, and then adding a measured volume of cold water. Allow to macerate, with frequent agitation, for from six to twelve hours; then filter through fine washed linen, and evaporate an aliquot portion of the solution. In this residue determine *total organic matter* and *ash*. This residue usually contains little but *gum*; in analysis of fruits and fleshy roots *pectin bodies, salts of organic acids*, rarely a substance resembling *dextrin*, and small amounts of *albuminous substances* and *colouring matter*. Usually the separation of these substances is very difficult. The unevaporated liquid should be used for such qualitative reactions as are necessary to show the nature of the substances extracted. The insoluble residue should be well washed with water, transferred to a crucible, and completely dried at 110° C. This residue should be then weighed.

VIII. *Estimation of Acid Extracts.*

The dried residue insoluble in cold water should be transferred to a beaker containing 500 c.c. of water and 5 c.c. of concentrated sulphuric acid (specific gravity 1·84). Boil for six hours, on a gauze support, adding water to keep the volume of liquid unchanged; if the substance be very starchy, a longer boiling may be necessary. This treatment will convert *starch* and its *amorphous isomers* to dextro-glucose, and will occasionally remove some *salt of an organic acid* with usually traces of *albuminous* and *indeterminate* substances.

The *total amount extracted* may be found by washing, drying at 110° C., and weighing the yet insoluble residue, and subtracting the weight from the one taken after extracting with cold water. The amount of *starch and isomers* may be found by determining in a given volume of the acid filtrate the amount of *glucose*, using Fehling's solution; the glucose thus found multiplied by 0·9 equals starch and isomers. The *total extract* minus *starch and isomers* equals *acid extract not starch*. This includes a small amount of *ash*, which may be approximately determined by evaporating and igniting a known volume of the solution.

Where it is wished to separate the extracted matter from the sulphuric acid, boil the liquid with an excess of powdered barium carbonate until no acid reaction remains. Filter, and evaporate to dryness. The residue consists chiefly of hydrated dextro-glucose ($C_6H_{12}O_6.H_2O$), with some ash.

IX. *Estimation of Alkali Extract.*

Wash well and dry at 110° C, the residue from treatment with acid, and record its weight. Boil this residue, for two hours, with 500 c.c. of a solution containing 20 grms. of sodic hydrate to the litre. Filter through fine washed linen, and wash the residue thoroughly with hot water, alcohol, and ether. Transfer it to a weighed crucible, dry at 110—120° C., and weigh the residue as *crude fibre* and *ash*: this weight subtracted from the previous one shows the *total alkali extract*. This extract is largely *albuminous matter* and various modifications of *pectic* acid, Fremy's "*cutose*," and various *colouring humus*, and *decomposition compounds* in small amounts. Most of the extracted substances may be precipitated by excess of an acid with or without the presence of alcohol.

* Chemical News, vol. xxxii., p. 19, from *Gaz. Chim. Ital.* 1875, No. 3; *Pro. Am. Ph. Assn.* 1875, p. 341.

X. *Cellulose.*

The crude fibre from IX. should be treated with from 50 to 100 c.c. of U.S.P. solution of chlorinated soda and allowed to stand twenty-four hours. If not then bleached white, slightly acidulate with hydrochloric acid, and set aside for another day. Filter through fine linen, or Gooch's filter, wash with hot water, dry at 110—120° C., and weigh, ash free, as *cellulose*. The loss of weight by this treatment state as *lignose* and *colour*.

Remarks.

It is advisable to determine always, in addition to what has already been directed, the amounts extracted directly from the sample by water, ether, alcohol of various percentages, methylic alcohol, naphtha, chloroform, carbon disulphide, &c. In each extract estimate *total organic matter* and *ash*, determine qualitatively, and quantitatively when possible, its constituents, by treating with such solvents and reagents as are indicated. Each extract being composed of certain distinct substances, it is necessary to account for them in every case.

The amounts present of some constituents may be found by subtracting the weight extracted by some one solvent from the weight extracted by some other. It will be seen that this is a method of limited applicability, which can only be applied in those cases where the difference between the solvent action of the two liquids is very sharply defined. Certain special methods for the estimation of single constituents may be used, care being taken that all interfering substances be first removed. The methods of preparation of known substances as given in Husemann's Pflanzenstoffe, and to a considerable extent in Watts's Dictionary, may serve as suggestions for work. Treatment with benzole, eighty per cent alcohol, and water, removes from nearly all plants the constituents of greatest chemical and medicinal interest, but in analyses of grains, fodder, and food materials those compounds extracted by dilute acids and alkalies have great value. There are substances in plants, seemingly isomers of starch and cellulose, which have properties more or less resembling those of cellulose, and are changed by boiling with dilute acids to glucose. In absence of an established nomenclature it has seemed best to use the term "starch isomers," or "amylaceous cellulose" for these substances,* while those constituents, *not albuminous*, which are removed by dilute alkali have been termed "alkali extract." These substances have been investigated by various chemists, but no definite and authoritative nomenclature has yet been adopted. Thomsen gives the name "holz-gummi,"† *wood-gum*, to a white substance extracted from plants by dilute sodic hydrate, while Fremy regards these various compounds as modifications of pectic acid, pectin, and "cellulose bodies."‡ Starch also may exist in some seeds (as of sweet corn) in a form soluble in water.§

It will be seen that the field for investigation is limitless, and almost unoccupied as yet, and that there is great need for improved methods for proximate analysis. The analyst will find that a study of any common plant will require of him much more than unthinking, mechanical habits of manipulation, while every careful investigation will reveal to him some constituents deserving more full and accurate study.

Reddening of Carbolic Acid.—H. Hager.—This change of colour which is occasionally observed in the purest carbolic acid, is ascribed to the absorption of ammonia, or rather of ammonium nitrite, from the atmosphere. In glass vessels hermetically sealed no change of colour takes place.—*Pharm. Central Halle.*

* U.S. Dept. of Agric. Report, 1878, p. 189.
† *Kolbe's Journ. Prak. Chem.*, band 19, p. 146.
‡ *Compt. Rend.*, lxxxiii., 1136; *Journ., Chem. Soc.*, 1877, p. 229.
§ U.S. Dept. Agric. Report, 1878, pp. 153—155.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 3, 1880.

Prof. H. E. Roscoe, President, in the Chair.

The President announced that a ballot would take place at the next meeting of the Society on June 17.

The following certificates were read for the first time:—J. K Crow, A. G. Chamberlain, H. A. Mott.

The President then called upon Mr. W. H. Perkin to read a paper "*On some Products of the Oxidation of Para-toluydin.*" In a previous paper on mauvein (*Journ. Chem. Soc.*, 1879, 728) the author briefly referred to some experiments on the oxidation of para-toluydin by chromic acid: the present paper continues the study of this reaction. A solution of the sulphate of para-toluydin was mixed with a solution of potassic dichromate. After twenty-four hours a large quantity of a brown precipitate formed. This was collected, washed, dried, and extracted with benzene. The benzene was coloured a rich orange-red, and on evaporation furnished a red crystalline product. After a great deal of trouble and many re-crystallisations this was separated into two new bases, one less soluble than the other. The least soluble gave on analysis numbers indicating the formula C_7H_7N. Its crystalline form has been described and figured by Mr. L. Fletcher. The substance melts at 216° to 220°: it crystallises in beautiful rhombohedral garnet-red crystals from benzol and ether. It readily dissolves in alcohol acidified with hydrochloric acid, forming a brownish red solution, changing to a red purple. With concentrated sulphuric acid this substance forms a magnificent blue colour. A platinum salt was formed, indicating as the formula for this substance $C_{21}H_{21}N_3$. It is designated by the author Tri-para-tolylene-triamine. The more soluble base was also obtained pure after much trouble. Analyses indicated the formula $C_{28}H_{27}N_3$. It may be derived from the preceding substance by replacing one atom of hydrogen by tolyl, and is therefore designated Toly-tri-para-tolylene-triamine. It melts at about 175° C., and dissolves in alcohol acidified with acetic acid with a purple colour; it separates from its ethereal solution in small, flat, prismatic crystals; it is an organic base, forming easily decomposable salts. In concentrated sulphuric acid it dissolves with a grey violet colour, quickly changing to a pale yellowish green. A platinum salt was prepared and analysed. No special advantage was obtained by substituting acetic for sulphuric acid in the oxidation process. By using a solution of para-toluydin in glacial acetic acid and a solution of chromic acid in the same solvent a different reaction was obtained. Golden-yellow needles were deposited, which, when purified, proved to be parazo-toluen; it fused at 143°.

Dr. Dupré then read a paper "*On the Detection of Foreign Colouring Matters in Wine.*" In January, 1876, the author proved that the true colouring-matter of wine dialysed very slowly (*Analyst*, 2, 26, and 11, 186), and that the various colouring matters, said to be used in adulterating wine, dialysed freely; also that small cubes of jelly, $\frac{3}{4}$" in the side, cut from a plate of jelly with a wet knife, could be used with great advantage in the analysis, as follows:—Such a cube immersed for a definite period in the wine is taken out, washed with a little water, and a central slice cut out. If the wine is pure it will be found that in 24 to 48 hours the colour has penetrated but a very little way into the cube, whereas many colouring matters will have reached the centre. Since then the author has extended his researches, and the present paper gives an account of experiments with many colouring matters, made as above described. The results confirm those already obtained. The colouring matter of pure wine dialyses very slowly. The only artificial colouring matter tried which does not dialyse quickly is that of alkanet root. Althæa, beet, bil-

berry, Brazil wood, carnation, cherry (red and black), clematis (purple), cochineal, cranberry, currant (red and black), elderberry, indigo, litmus, logwood, mallow, raspberry, red cabbage, red poppy, rhatany root, rosanilin, saffron and strawberry, all dialyse, and penetrate rapidly into the jelly. Alkanet can be readily distinguished from the colouring matter of wine by giving an absorption spectrum of three bands in acid solution. Ammonia changes wine colouring matter to greenish brown, which gives one indistinct absorption-band in the yellow. Alkanet is turned blue, and gives two absorption-bands. The nature of the colouring-matter can often be detected by the colour of the gelatin cube, *e.g.*, indigo, logwood, &c.; if not, it is best to dialyse the wine through parchment-paper, and then apply the tests suggested by Gautier and others to the dialysate. The cubes of jelly are cut from a jelly containing 10 per cent of dry gelatin, to which it is preferable to add 10 per cent of glycerin.

The PRESIDENT asked if Dr. Dupré could account for the non-diffusibility of the colouring matter: whether it was of an albuminous nature?

Dr. FRANKLAND suggested that the colouring matter might be in suspension: that it did not subside was no evidence against this view, as gold had been obtained by Faraday in a state of suspension so fine that it did not settle after many years standing.

Prof. EMERSON REYNOLDS asked if the age of the wine did not alter the dialysing power of the colouring matter.

Mr. PAGE suggested, as a substitue for the sheets of paper stretched on hoops, usually employed in dialysis, tubes made of parchment-paper, which could be obtained of almost any length, and were very convenient, as no joint had to be made. They can be obtained of Karl Brandegger, Ellwangen, Würthemberg, at 4 to 5 shillings per 100 metres.

Dr. DUPRÉ, in reply, did not think that the colouring matter was albuminous, but that it resembled somewhat a tannin. In his opinion the colouring matter was not in suspension, in proof of which it did not colour the must until sufficient alcohol had formed to bring it into solution. He had examined 1834 port and two-year old port without detecting any difference in the dialysing power of the colouring matter.

The two following papers were read by Dr. FRANKLAND:—

"*On the Action of Organo-zinc Compounds upon Nitriles and their Analogues.* I. *Action of Zinc-ethyl on Azobenzene*," by E. FRANKLAND and D. A. LOUIS. When azobenzene is added to an ethereal solution of zinc-ethyl, and the mixture warmed to the boiling-point of the ether, a reaction commences, accompanied with the evolution of much gas. As soon as it ceases it can be continued by adding a fresh quantity of azo-benzene, and so on until the reaction becomes sluggish, care being taken to employ an excess of zinc-ethyl. An amber coloured jelly was thus obtained: it was decomposed by water, much gas being evolved; a reddish brown oil separated out with the zincic hydrate. By treatment with caustic soda the zincic hydrate was removed. The oil thus obtained was purified, and proved by analysis, &c., to consist mainly of aniline. The gas evolved during the reaction consisted of 3 vols. of ethylene and 1 vol. of ethylic hydride. From 80 grms. of azo-benzene 70 grms. of aniline were obtained. Besides the aniline, a small quantity of a high boiling-point viscid oil was obtained, the investigation of which is not yet complete.

"II. *On the Action of Zinc-ethyl upon Benzo-nitrile*," by E. FRANKLAND and J. CASTELL EVANS. Equal volumes of zinc-ethyl and benzo-nitrile were heated in a sealed tube to 150°. On cooling the contents solidified to a brownish mass. After treatment with alcohol and hydrochloric acid, white needles remained, sparingly soluble in alcohol, but dissolving readily in carbon disulphide, fusing at 229°. By analysis, &c., this substance was proved to be cyaphenine, $C_{21}H_{15}N_3$. The above reaction also takes place under ordinary pressure. On heating cyaphenine with concentrated hydrochloric acid in a sealed tube to 250° it can be converted entirely into benzoic acid and ammonia. The liquid obtained by treating the product of the zinc-ethyl reaction (after decomposition by alcohol) with hydrochloric acid deposited, on standing, faintly greenish six-sided plates. These, after purification, gave numbers indicating the formula $C_{17}H_{21}N_2Cl$. A further investigation of this hydrochlorate, which fuses at 257°, is promised. The gas evolved during the action of zinc-ethyl on benzo-nitrile consisted of equal volumes of C_2H_4 and C_2H_6.

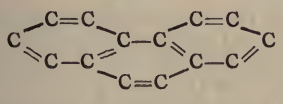
Dr. ARMSTRONG suggested that it would be better to get rid of such terms as ethylic hydride. The researches of Dale and Schorlemmer had proved that there was no difference between ethane and ethylic hydride: moreover, the latter name suggested a distinction between one atom of hydrogen and the other atoms of that element which did not exist.

Dr. FRANKLAND quite agreed with Dr. Armstrong as to the desirability of abolishing the term if the identity of the two substances was fully proved; but, in his opinion, we should be very careful in abolishing an idea because it did not conform to the theories of the day. He quite admitted that Schorlemmer had proved the identity of a fraction of the products of the action of Cl on the two gases, but nothing had been done with the remainder of the products. He had waited for several years for any further investigation of the subject, and at last had determined to take up the question himself.

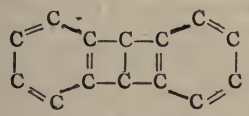
Dr. JAPP contended for the convenience of the term methylic hydride, irrespective of the question of isomerism, as in Butlerow's reaction.

Prof. HARTLEY then read a communication "*On the Relation between the Molecular Structure of Carbon Compounds and their Absorption-spectra.*" In a previous paper, in which the author was associated with Prof. A. K. Huntington, it has been shown (1) that every increment of CH_2 in a homologous series of alcohols or of acids effects an absorption of the more refrangible of the ultra-violet rays, so that the greater the number of carbon atoms in the molecule the shorter is the transmitted spectrum; (2) that the terpenes always transmit continuous spectra, but polymerisation largely increases their absorptive power; (3) that benzene and its derivatives invariably show, in addition to abnormally great absorptive power, the peculiarity of absorption-bands. After taking into consideration the numerous substances examined the conclusion seems inevitable that banded absorption-spectra were caused by the double linking of three pairs of carbon atoms in a compactly closed chain; and in the present paper the author has studied the effects of various atomic groupings on the absorption of ultra-violet rays. The first question was whether substances with two doubly-linked adjacent carbon atoms exhibit any peculiarities in their absorption-spectra. To decide this point, ethylene, amylene, and allyl alcohol were selected for examination, but in neither case were any absorption-bands seen. To ascertain the effect of the treble linking of two carbon atoms, the spectra of acetylene and valerylene were examined, but no absorption-bands were noticed. In all cases, therefore, where the carbon atoms are arranged in an open chain no absorption-bands are seen. In no carbon compound has any arrangement of the hydrogen or oxygen atoms been identified with the presence of absorption-bands. With hydrocarbons containing at least six atoms of carbon and their derivatives there are three possible arrangements which admit of the carbon atoms forming a closed chain:—(1) Three pairs of carbon atoms may be doubly linked, as is assumed to be the case in benzene; (2) two pairs may be doubly linked; (3) the six atoms may be singly linked. There are reasons for believing that oil of turpentine and terebene have two pairs of carbon atoms doubly linked, and that a closed chain, including these two pairs of atoms, forms the nucleus of such substances. These bodies exhibit no absorption-bands, so the author concludes that a closed chain of carbon atoms, in which only two pairs are doubly linked,

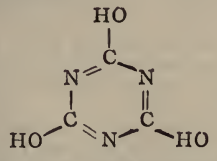
exhibits no absorption-bands. Now the constitutional formula of camphor is probably founded on a closed chain of carbon atoms. It is found to be very diactinic, more diactinic than the terpenes, so that probably its atoms are not so compactly united; this is consistent with a singly linked closed chain of carbon atoms. Camphoric acid similarly shows no absorption-bands. The author therefore concludes that no molecular arrangement of carbon atoms causes selective absorption unless three pairs are doubly linked together in a closed chain. The author next considers the absorption-spectra of condensed benzene nuclei. It was expected, from the generally accepted views as to the constitution of naphthalene and anthracene, that these substances would give a larger number of absorption-bands than benzene, and that the bands would be of greater intensity, *i.s.*, they would be capable of withstanding a great degree of dilution before they disappeared. The results obtained are rather remarkable; thus, a solution of naphthalene containing 1 in 60,000 shows four strongly-marked bands. Phenanthren contains the carbons of three benzene rings disposed as follows:—



It shows three strong absorption-bands in a solution containing 1 in 4000. Anthracene, which may be considered to have a structure—



was also examined. It was dissolved in glacial acetic acid. It has a considerable absorption when the dilution is carried as far as 1 in 50 millions. Pyridin gives an absorption-spectrum. Hydrocyanic acid is very diactinic. Cyanuric acid is not, and the author concludes that it has the formula—



Photographs of many of the spectra were exhibited.

The President congratulated Prof. Hartley on his interesting results; such work was of the greatest importance. The question as to the connection between structure and physical properties would probably form one of the most interesting chapters in the chemistry of the coming time.

Mr. Groves asked if Prof. Hartley had investigated the effect of substitution in the the side chains.

Prof. Emerson Reynolds asked if the absorption-spectra were sufficiently definite to identify the various substances. The work seemed to him to be most important; it gave some air of reality to the three links and two links of which chemists now speak so frequently.

Dr. Japp suggested the investigation of the class of trimolecular nitriles, so as to have compounds with a closed chain like the benzene ring.

Prof. Hartley, in reply, said that if the substances were pure it was perfectly easy to identify them, and the quantity of some substances, even in mixtures, could be roughly estimated.

"*On a Simple Method of Determining Vapour-densities in the Barometer Vacuum.*" by C. A. Bell and F. L. Teed. Notwithstanding the simplicity of the apparatus recently proposed by Meyer, many cases remain—*e.g.*, those of easily decomposable substances of high boiling-point, &c.—in which the older method of Hofmann would be preferable. Moreover most liquids volatilise in a vacuum at 100°, and this temperature can easily be maintained for any length of time. The authors have introduced two new devices:—(1) By varying the external pressure, or otherwise the vapour is made to occupy a known volume; and (2) its pressure is directly determined by a single observation, which is independent of the atmospheric pressure. Thus the calculations are enormously simplified, and errors of observation are avoided. The simplest form of the apparatus consists of a glass cylinder, 34 c.m. long and 3·3 c.m. internal diameter, closed at its upper end. To its lower end is fused a stout glass tube, 8 m.m. internal diameter and 83 c.m. long. 5 c.m. below the junction with the cylinder a glass tube is fused in so as to form a T, and bent up so as to be parallel with the cylinder; it is sealed off a little below the upper end of the cylinder. The lower end of the long glass tube is closed by an india-rubber cork, through which passes a glass stopcock. The whole of the upper part of the apparatus is surrounded by a steam jacket. A fine line is etched on the glass tube about 1 c.m. below its junction with the cylinder, and from a point on exactly the same level the side tube, which serves as a barometer, is graduated upwards in millimetres. The apparatus is filled with mercury, and after various precautions, the liquid introduced in a thin glass bulb, converted into vapour, and the pressure in the barometer tube observed, at which the vapour depresses the mercury to the mark etched on the tube. The volume of the cylinder being known the calculation is extremely simple.

Mr. Kingzett communicated verbally some results on the Oxidation of Phosphorus in Moist Air. He had proved that under these circumstances, both ozone and peroxide of hydrogen were formed. Details are promised in a future paper.

The Society then adjourned to June 17, when a ballot for the election of Fellows will be held, and the following papers read:—"On Penta-thionic Acid," by T. Takamatsu and Watson Smith; "On a Crystal of Diamond," by Harry Baker; "Some Orcinol Derivatives," by J. Stenhouse and C. E. Groves; "On the Determination of Carbon in Soils," by R. Warington and W. A. Peake; "Note on Camphydrene," by H. E. Armstrong; "On the Action of Nitric Acid on Dipara-tolyl-guanidine," by A. G. Perkin.

MINERALOGICAL SOCIETY.

At a meeting of the above Society on June 1, at 116, Victoria Street, S.W., Prof. Bonney, F.R.S., presiding, a paper on "Recent Mineral- and Metal-Growth at Ordinary Temperatures, under Ordinary Conditions," was read by Mr. Readwin, F.G.S., who illustrated his novel views by the exhibition of interesting examples in gold, silver, copper, iron, diamond, &c.

CORRESPONDENCE.

HYDROMETERS.

To the Editor of the Chemical News.

Sir,—In testing the strengths of liquors, both in the laboratory and the works, it is often necessary to use the utmost expedition—not a moment is to be lost in getting hold of the right hydrometer. At present, in cases where five or six Twaddle hydrometers of different strengths are in use, most valuable time is frequently lost in hunting for the number upon the stem till the proper hydrometer can be got hold of. I beg, therefore, to offer the following simple suggestion to enterprising makers of hydrometers,

knowing that it would be of substantial service to their customers :—

The paper upon which the figures are printed to be continued right up to the top of the stem, and upon it, near the top, thick black bars to be printed, corresponding with the number upon the hydrometer—one for No. 1, two for No. 2, and so on. The bars to be placed in pairs—one pair for No. 2, a pair and an additional bar for No. 3, two pairs for No. 4, and so on, as the eye can more instantaneously read off this arrangement than bars at equal distances.—I am, &c.,

FRANK.

June 4. 1880.

SPENCE'S METAL.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS, vol. xli., p. 87, you give the substance of a paper read before the Society of Arts, by Mr. Granville Cole, Ph.D., in which he predicted an extensive field for the useful application of the so-called Spence's metal for many industrial purposes. Will you kindly inform me as to whether this compound has ever been tried on the large scale, and if so with what success; also, as to where it may be obtained in quantity sufficient to determine its value for manufacturing purposes?—I am, &c.,

W. GOLDSBOROUGH WHITTAM.

WATER ANALYSIS.

To the Editor of the Chemical News.

SIR,—I reserve what I have to say in answer to the criticisms of Dr. Frankland and others (and I have a good deal to say) on my paper on "River Water" until such time as I can reply in detail.

Dr. Mills's letter, however (CHEMICAL NEWS, vol. xli., p. 260), calls for one remark. He says:—"It is not therefore possible to calculate from the 'oxygen consumed' by any given water how much organic matter it contains." Granted: and if Dr. Mills had added, "nor by any other known process" he would have been equally as correct. For the combustion process is no more an *absolute* test of the quantity of organic matter in a water than the oxygen process.

Let me state a case in illustration. If I were to send Dr. Mills for analysis a sample of distilled water containing sufficient hydrocyanic acid to poison a household, he would report to me that, judged by the combustion process, the water was perfectly wholesome and free from organic matter of an injurious nature.—I am, &c.,

C. MEYMOTT TIDY.

3, Mandeville Place, Manchester Sq., W.,
June 5, 1880.

WATER ANALYSIS.

To the Editor of the Chemical News.

SIR,—I read Mr. Kingzett's paper on "Organic Matter in Water" (CHEMICAL NEWS, vol. xli., p. 254) with much interest. Mr. Kingzett conceives "that under certain circumstances a water might be found containing such a small amount of organic matter in a given volume that it would be passed by Tidy's process as of 'great organic purity,' and yet might under given conditions pass into a state of putridity, and therefore become pernicious." He is quite right in his supposition. A fairly large experience, extending now over a good many years of cases of typhoid fever caused by impure water, enables me to affirm unhesitatingly that the worst waters are frequently those that contain the smallest amount of organic matter, possibly, as Mr. Kingzett says, for the reason "that as it becomes less in quantity it becomes more pernicious in quality." My experience as a chemist entirely bears out Prof. Huxley's opinion, as a biologist, that so far as organic matter is concerned "a water may be as pure as can be as regards chemical analysis, and yet be as regards the human body as deadly as prussic acid." As I have recently published my views on this subject at some length ("Potable Water," published by J. and A. Churchill), I will only say here that to lay the chief stress on organic matter by whatever process it may be estimated is worse than useless. It is the *nature* of the organic matter as testified to by collateral chemical evidence that is the all-important item.—I am, &c.,

CHARLES EKIN, F.C.S.

June 8, 1880.

AMMONIA FROM THE NITROGEN OF THE ATMOSPHERE.

To the Editor of the Chemical News.

SIR,—Will you kindly allow me to say a few "last words" in reply to the long letter of E. S., in the CHEMICAL NEWS, vol. xli., p. 259.

I wish to say that I am not anxious that my representation of this matter should be taken without question. I simply desire that those who are interested in the matter should examine the two specifications and my note in answer to the bare assertion in E. S.'s first note as to anticipation or infringement, and there I am content to leave the matter.

But as to this letter I should like to make a few observations. In the specification of T. C. and E. S. it is directed that the nitrogen be heated to an "intensely high heat," and "as high a heat as possible," and also that the nitrogen and hydrogen be kept at a "prolonged white heat" to bring them to the "nascent or atomic state"! that it may be possible for combination to take place. But in this letter E. S. says his experience tells him that a "full red heat" is all that is necessary, and this, he says now, is a high heat. But surely he does not mean to call this red heat white, either prolonged or otherwise, which the specification asserts to be necessary. Now a white heat is far from as "high a heat as possible," even in a fire-clay furnace, which heat the specification also directs to be produced.

According to the experiments of M. Pouillet on heated furnaces, a full red heat is equal to about 916° C.; a white heat is equal to about 1316° C.; and a dazzling white heat to about 1516° C.

Next, as to the decomposition of ammonia at a red heat. About this there can be no doubt; the fact is stated in every chemical primer. But if a red heat destroys ammonia, then free ammonia cannot exist at that heat; but ammonium chloride can, and this is why we prefer to make that salt direct.

We have long ago made the experiments suggested by E. S. We have used as a deoxidising medium coke, wood-charcoal of different kinds, and peat-charcoal, which are non-nitrogenous. But besides these, we have used various other substances, which we have taken care were absolutely free from nitrogen, and in all cases have found the result the same under similar conditions. The cheapness of coal-dust alone determined us in favour of it.

Finally, E. S. says that the leading idea in the patent of T. C. and E. S. is the decomposition of water and utilising the H in the formation NH_3; but this is precisely the leading idea in very many patents for the last thirty years, so that I am afraid T. C. and E. S. have been "anticipated" many times over.—I am, &c.,

J. B. THOMPSON.

Reducing Agents in Refining Copper and Obtaining Copper Alloys.—M. Levitzki.—Manganese, in the form of copper manganese, is the best agent for reducing the oxides mixed with the copper of commerce.—*Berg. u. Hütten Zeitung.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 18, May 3, 1880.

Gases retained by Occlusion in Aluminium and Magnesium.—M. Dumas.—On submitting aluminium in a vacuum to the action of a temperature gradually raised to the softening-point of porcelain, and causing the mercurial pump to act upon the retort containing the metal till it is completely exhausted, considerable quantities of gas are withdrawn. The liberation of the gas from the metal seems to take place suddenly towards a white-red heat. 200 grms. aluminium, occupying 80 c.c., gave 89·5 c.c. of gas at the temperature of 17° and the pressure of 755 m.m. The gas consisted of carbonic acid 1·5, and hydrogen 88 c.c. Carbonic oxide, nitrogen, and oxygen were absent. Magnesium, on similar treatment, gave off, weight for weight, double the volume of gas evolved by aluminium, 20 grs. of the metal giving 12·3 c.c. hydrogen and 4·1 c.c. carbonic oxide. Another specimen of magnesium evolved hydrogen 28·1 c.c., carbonic oxide 1·9 c.c., and carbonic acid 1·5 c.c. The magnesium which is volatilised in the retort crystallises on condensing, and may serve for re-determining the atomic weight of the metal, which is open to some doubts. Further, the vapour-density of magnesium may be determined by volatilising it in a vacuum. It appears, then, that hydrogen is occluded by magnesium and aluminium, as is oxygen by silver. It is possible that other gases may be selected by other metals.

Experimental Researches on the Decomposition of Certain Explosives in Closed Vessels; Composition of the Gases Formed.—MM. Sarrau and Vieille.—The explosives experimented upon were pure gun-cotton, gun-cotton mixed with equal parts potassium nitrate, mixture of 40 parts gun-cotton and 60 ammonium nitrate, nitro-glycerine, and common mining powder. The composition of the resulting gases is given in a table. The mining powder alone yielded a hydrocarbon and hydrogen sulphide, and in common with pure gun-cotton, carbonic oxide, and free hydrogen. The other three compounds evolved free oxygen, and their carbon was entirely liberated as dioxide.

General Equation, giving the Relation for all Liquids between their Temperature and the Maximum Tension of their Vapours at this Temperature.—Raoul Pictet.—A mathematical paper, not susceptible of useful abstraction.

Laws which Govern Matter in the Spheroidal State.—P. H. Boutigny.—1. The temperature of bodies in the spheroidal state is always below their ebullition-point; that of water is +97°. 2. A body in the spheroidal state never places itself in an equilibrium of temperature with the containing vessel; its temperature is always in a state of stable equilibrium, where it is in a capsule in the open air, or in the muffle of a cupelling furnace. But if the body in the spheroidal state does not place itself in an equilibrium of temperature the emanating vapour always does. These two phenomena are very distinctly manifested on operating in a hollow sphere. 3. Matter in the spheroidal state reflects radiant heat. 4. The volumes of matter in the spheroidal state are inversely as their densities. 5. There is a repulsive force at a sensible distance, so that the water, &c., is not sustained in the capsule by being enveloped in watery vapour.

Dissociation of Butyl-chloral Hydrate.—MM. R. Engel and Moitessier.—The authors consider that their experiments give further confirmation to the law that the dissociation of a body, both of whose constituents are volatile, does not take place in presence of the vapour of one of the components at a tension higher than the dissociation tension of the compound.

Determination of Glycerin in Wines.—M. Raynaud.—The determination of glycerin is easily effected with exactness in pure wines, but the same process gives erroneous results in plastered wines containing potassium sulphate. The glycerin holds in solution potassium carbonate and extractive matter, even in presence of a mixture of ether and alcohol. The author therefore proceeds as follows:—He evaporates the wine to one-fifth of its volume, adds hydro-fluosilicic acid, and then alcohol. The alkalies are thus thrown down, and the fluo-silicates may be collected if it is intended to determine the potassium and sodium. A slight excess of barium hydroxide is then added, and the whole is evaporated to dryness with a quantity of quartz sand. The residue is exhausted with a mixture of alcohol and ether, absolutely pure, the solution is slowly evaporated, and the residue is left for twenty-four hours in a dry vacuum over phosphoric anhydride. It is pure glycerin.

On Legumin.—A. Bleunard.—The reaction of barium hydroxide upon legumin yields the same results as upon albumin. There is a little more carbonic acid produced and a little less oxalic and acetic acid. There is in the fixed residue of legumin an excess of the gluco-proteins, $C_7H_{14}N_2O_4$, and $C_{10}H_{20}N_2O_4$, whilst the gluco-protein, $C_9H_{18}N_2O_4$, which is dominant in albumen is rarer in legumin.

On Gelose.—M. Porumtaru.—The author assigns to gelose the formula $C_6H_{10}O_5$, which is analogous to that of the starch of lichenin, inulin, and tunisin.

Chemiker Zeitung.
No. 12, 1880.

Physiological Action of Tar Colours and their Organic Raw Materials.—Dr. Grandhomme.—Already noticed.

New Reaction with Gum.—C. Reichel.—The carbohydrates yield coloured compounds with phenols in presence of acids. If gum and orcin are boiled for a time in concentrated hydrochloric acid a red colouration appears, which passes into violet, and a blue colouring-matter is ultimately deposited. On the addition of alcohol a greenish blue solution is produced, which, on the addition of alkalies, turns violet with a green fluorescence. Similar is the behaviour of cherry-gum and bassorin, whilst dextrin, starch, cellulose, grape-sugar, cane-sugar, and milk-sugar, if similarly treated, yield yellow or brownish colourations, which dissolve in alcohol with a yellow or orange colour. Their alkaline solutions have a greenish fluorescence.—*Ber. Oest. Ges. Förd. Chem. Industrie.*

Detection of Mercury.—H. v. Jüptner.—Scarlet mercuric iodide appears perfectly white in the light of the sodium flame.

Die Chemische Industrie.
No. 1, January, 1880.

Regulations concerning the Sale of Alcohol Duty-free for Industrial Purposes.—To each litre of absolute alcohol present in the sample, at least 0·1 litre of wood-spirit must be added. Only such wood-spirit is to be used which has been sanctioned by the excise authorities, and has remained in bond until required for use. The wood-spirit must be tested as to its specific gravity, boiling-point, miscibility with water, and soda-lye, and power of taking up bromine.

Notes on the Chemical Manufactures of the South of France.—Sulphate of soda is manufactured by Pechiney and Co. by the application of artificial cold. The mother-liquors of the salt works containing sodium chloride and magnesium sulphate (*sel mixte*) are cooled down to −6°

by the aid of a Carré freezing machine. The Glauber's salt is deposited as a crystalline mud, and is raised by elevators into draining receptacles [This seems to be a very close approach to Fournier's patent.—*Ed.* C.N.], and is then dehydrated as follows:—About 1500 kilos. are melted in a little mother-liquor in a wooden cistern, heated by means of a copper worm, and provided with an agitator. About 250 kilos. of common salt are then added. In proportion as the salt dissolves, anhydrous sulphate of soda is precipitated, and at the end of the process 85 per cent of the total amount are found thrown down free from water. The hot saline paste flows down from the precipitation tank into a filter cask with a double perforated bottom, and after it has drained it is placed in centrifugal machines, from which it is removed containing only 0·5 sodium chloride and 5 per cent water.

Comparison of the Apparatus for the Concentration of Sulphuric Acid according to the Systems of Delplace and Prentice.—G. Delplace.—The author contends that his arrangement requires less platinum and less fuel, and yields a larger quantity of concentrated acid.

MISCELLANEOUS.

Chemical Specimens.—We hear from Dr. Theodor Schuchardt, of Goerlitz, that he has prepared metallic potassium in fine large crystals (*octahedre quadratic*), 1 to 1·1 centims. long, preserved in closed tubes in an atmosphere of purified hydrogen; metallic sodium, but in smaller crystals; the alloy of 1 equivalent of K with 1 equivalent Na, like mercury, solidifying at −8° C., preserved in hydrogen; metallic chromium in small regular octahedra, by fusion of sesquichloride of chromium, zinc, and chloride of sodium.

MEETINGS FOR THE WEEK.

SATURDAY, 12th.—Physical, 3. Dr. R. C. Shettle, "On the Earth's Rotation as Influenced by Solar Energy." R. H. Ridout, "Note on a Simple Method of Amplifying Small Motions."
MONDAY, 14th.—Royal Geographical, 8.30.
TUESDAY, 15th.—Zoological, 8.30.
WEDNESDAY, 16th—Meteorological, 7.
THURSDAY, 17th.—Chemical, 8. T. Takamatsu and Watson Smith, "On Penta-thionic Acid." Harry Baker, "On a Crystal of Diamond." J. Stenhouse and C. E. Groves, "Some Orcinol Derivatives." R. Warington and W. A. Peake, "On the Determination of Carbon in Soil." H. E. Armstrong, "Note on Camphydrene." A. G. Perkin, "On the Action of Nitric Acid on Dipara-tolylguanidine." Ballot for the Election of Fellows.
— Royal, 4.30.
— Philosophical Club, 6.30.

TO CORRESPONDENTS.

Subscriber.—Apply to Peter Spence and Co, Pendleton Alum Works, Manchester.

THE JOURNAL OF SCIENCE
for June (Price 1s. 6d.), includes—
Insanity and its Difficulties.
The History of Antozone and Peroxide of Hydrogen. By Albert R. Leeds, Ph.D.
The Origin of Falling Motion. By Charles Morris.
The Aurora.
Flighty Aspirations. By Fred. W. Brearey, Hon. Secretary to the A.S.G.B.
Analyses of Books. Correspondence. Notes.
London: 3, Horse-Shoe Court, Ludgate Hill.

FILTER-PRESSES.—A few 18 Iron Presses to be Sold Cheap, to clear out Stock; also Patterns.—Address, X X., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

MANCHESTER CORPORATION GAS WORKS.
TO TAR DISTILLERS AND OTHERS.
The Gas Committee are prepared to receive TENDERS for the purchase of the whole or a portion of the Gas Tar to be produced at their Gaythorn and Rochdale Road Works during a period of three or more years, commencing on the 1st day of March, 1881.
Sealed Tenders addressed to the Chairman of the Gas Committee, Town Hall, Manchester, and endorsed "Tender for Gas Tar," must be delivered here on or before Wednesday, the 16th day of June next. The Committee do not bind themselves to accept the highest or any Tender.
Further particulars and forms of Tender may be obtained on application to Mr. Geo. B. Jackson at the Gas Office.—By Order,
JOS. HERON, Town Clerk.
Town Hall, Manchester, May 15, 1880.

GREENBANK ALKALI WORKS COMPANY (LIMITED),
ST. HELENS LANCASHIRE.
CELEBRATED RED HEART BRAND.
DOUBLE REFINED CAUSTIC SODA—Solid in Drums, or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{2}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.
PURE CAUSTIC POTASH—In Iron Drums of any size Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.
REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.
BICARBONATE OF POTASH—Perfectly pure white; finely powdered.
CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.
PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.
Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

WILLIAM AND WILLIAM T. FIELD
MANUFACTURERS of the Celebrated STAFFORDSHIRE BLUE BRICKS, specially adapted for Chemical Plant, *i.e.*, Acid Towers, &c. Also all other kinds of Best Staffordshire Blue Bricks, Pavings, Plynths, Splays, Copings, &c. &c. Prices and samples on Application.
TESTIMONIAL.
"We have used the Blue Staffordshire Brick or Sulphuric Acid Towers, &c., manufactured by Messrs. Field, for the last fifteen years, during which time they have given great satisfaction. We recommend them to the Chemical Trade, believing there is nothing better in the market."—(Signed) WILLIAM HUNT and SONS, Lea Brook Alkali Works, near Wednesbury, Staffordshire, February, 1878.
TOLL END BRICK-WORKS,
TIPTON, STAFFORDSHIRE.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

THE CHEMICAL NEWS.

Vol. XLI. No. 1073.

ON A FOURTH STATE OF MATTER.*

In a Letter to the Secretary of the Royal Society.

By W. CROOKES, F.R.S.

7, Kensington Park Gardens, London, W., April 29, 1880.

Dear Professor Stokes,

In introducing the discussion on Mr. Spottiswoode and Mr. Moulton's paper on the "Sensitive State of Vacuum Discharges," at the meeting of the Royal Society on April 15, Dr. de la Rue, who occupied the Chair, good-naturedly challenged me to substantiate my statement that there is such a thing as a fourth or ultra-gaseous state of matter.

I had no time then to enter fully into the subject; nor was I prepared, on the spur of the moment, to marshall all the facts and reasons which have led me to the conclusion. But as I find that many other scientific men besides Dr. de la Rue are in doubt as to whether matter has been shown to exist in a state beyond that of gas, I will now endeavour to substantiate my position.

I will commence by explaining what seems to me to be the constitution of matter in its three states of solid, liquid, and gas.

1. First as to solids:—These are composed of discontinuous molecules, separated from each other by a space which is relatively large—possibly enormous—in comparison with the diameter of the central nucleus we call *molecule*. These molecules, themselves built up of *atoms*, are governed by certain forces. Two of these forces I will here refer to—attraction and motion. Attraction when exerted at sensible distances is known as gravitation, but when the distances are molecular it is called *adhesion* and *cohesion*. Attraction appears to be independent of absolute temperature; it increases as the distance between the molecules diminishes; and were there no other counteracting force the result would be a mass of molecules in actual contact, with no molecular movement whatever—a state of things beyond our conception—a state, too, which would probably result in the creation of something that, according to our present views, would not be *matter*.

This force of cohesion is counterbalanced by the movements of individual molecules themselves, movements varying directly with the temperature, increasing and diminishing in amplitude as the temperature rises and falls.

The molecules in solids do not travel from one part to another, but possess adhesion and retain fixity of position about their centres of oscillation. Matter, as we know it, has so high an absolute temperature that the movements of the molecules are large in comparison with their diameter, for the mass must be able to bear a reduction of temperature of nearly 300° C. before the amplitude of the molecular excursions would vanish.

The state of solidity therefore—the state which we are in the habit of considering *par excellence* as that of *matter*—is merely the effect on our senses of the motion of the discrete molecules among themselves.

Solids exist of all consistences, from the hardest metal, the most elastic crystal, down to thinnest jelly. A perfect solid would have no viscosity, *i.e.*, when rendered discontinuous or divided by the forcible passage of a harder solid, it would not close up behind and again become continuous.

In solid bodies the cohesion varies according to some unknown factor, which we call chemical constitution; hence each kind of solid matter requires raising to a different temperature before the oscillating molecules lose their fixed position with reference to one another. At this point, varying in different bodies through a very wide range of temperature, the solid becomes liquid.

2. In liquids the force of cohesion is very much reduced, and the adhesion or the fixity of position of the centres of oscillation of the molecules is destroyed. When artificially heated, the inter-molecular movements increase in proportion as the temperature rises, until at last cohesion is broken down, and the molecules fly off into space with enormous velocities.

Liquids possess the property of viscosity—that is to say, they offer a certain opposition to the passage of solid bodies; at the same time they cannot permanently resist such opposition, however slight, if continuously applied. Liquids vary in consistency from the hard, brittle, apparently solid pitch, to the lightest and most ethereal liquid capable of existing at any particular temperature.

The state of liquidity, therefore, is due to inter-molecular motions of a larger and more tumultuous character than those which characterise the solid state.

3. In gases the molecules fly about in every conceivable direction, with constant collisions and enormous and constantly varying velocities, and their mean free path is sufficiently great to release them from the force of adhesion. Being free to move, the molecules exert pressure in all directions, and were it not for gravitation they would fly off into space. The gaseous state remains so long as the collisions continue to be almost infinite in number, and of inconceivable irregularity. The state of gaseity, therefore, is pre-eminently a state dependent on collisions. A given space contains millions of millions of molecules in rapid movement in all directions, each molecule having millions of encounters in a second. In such a case, the length of the mean free path of the molecules is exceedingly small compared with the dimensions of the containing vessel, and the properties which constitute the ordinary gaseous state of matter, which depend upon constant collisions, are observed.

What, then, are these molecules? Take a single lone molecule in space. Is it solid, liquid, or gas? Solid it cannot be, because the idea of solidity involves certain properties which are absent in the isolated molecule. In fact, an isolated molecule is an inconceivable entity, whether we try, like Newton, to visualise it as a little hard spherical body, or with Boscovich and Faraday, to regard it as a centre of force, or accept Sir William Thomson's vortex atom. But if the individual molecule is not solid, *à fortiori* it cannot be regarded as a liquid or gas, for these states are even more due to inter-molecular collisions than is the solid state. The individual molecules, therefore, must be classed by themselves in a distinct state or category.

The same reasoning applies to two or to any number of continuous molecules, provided their motion is arrested or controlled, so that no collisions occur between them; and even supposing this aggregation of isolated non-colliding molecules to be bodily transferred from one part of space to another, that kind of movement would not thereby cause this molecular collocation to assume the properties of gas; a molecular wind may still be supposed to consist of isolated molecules, in the same way as the discharge from a mitrailleuse consists of isolated bullets.

Matter in the fourth state is the ultimate result of gaseous expansion. By great rarefaction the free path of the molecules is made so long that the hits in a given time may be disregarded in comparison to the misses, in which case the average molecule is allowed to obey its own motions or laws without interference; and if the mean free path is comparable to the dimensions of the containing vessel, the properties which constitute gaseity are reduced to a minimum, and the matter then becomes exalted to an ultra-gaseous state.

But the same condition of things will be produced if by any means we can take a portion of gas, and by some extraneous force infuse order into the apparently disorderly

* A Paper read before the Royal Society, June 10, 1880.

jostling of the molecules in every direction, by coercing them into a methodical rectilinear movement. This I have shown to be the case in the phenomena which cause the movements of the radiometer, and I have rendered such motion visible in my later researches on the negative discharge in vacuum tubes. In one case the heated lampblack and in the other the electrically excited negative pole supplies the *force majeure* which entirely or partially changes into a rectilinear motion the irregular vibration in all directions; and according to the extent to which this onward movement has replaced the irregular motions which constitute the essence of the gaseous condition, to that extent do I consider that the molecules have assumed the condition of radiant matter.

Between the third and fourth states there is no sharp line of demarcation, any more than there is between the solid and liquid states, or the liquid and gaseous states; they each merge insensibly one into the other. In the fourth state properties of matter which exist even in the third state are shown *directly*, whereas in the state of gas they are only shown *indirectly*, by viscosity and so forth.

The ordinary laws of gases are a simplification of the effects arising from the properties of matter in the fourth state; such a simplification is only permissible when the mean length of path is small compared with the dimensions of the vessel. For simplicity's sake we make abstraction of the individual molecules, and feign to our imagination *continuous* matter of which the fundamental properties—such as pressure varying as the density, and so forth—are ascertained by experiment. A gas is nothing more than an assemblage of molecules contemplated from a simplified point of view. When we deal with phenomena in which we are obliged to contemplate the molecules individually, we must not speak of the assemblage as *gas*.

These considerations lead to another and curious speculation. The molecule—intangible, invisible, and hard to be conceived—is the only true *matter*, and that which we call matter is nothing more than the effect upon our senses of the movements of molecules, or, as John Stuart Mill expresses it, "a permanent possibility of sensation." The space covered by the motion of molecules has no more right to be called matter than the air traversed by a rifle bullet can be called lead. From this point of view, then, matter is but a mode of motion; at the absolute zero of temperature the inter-molecular movement would stop, and although *something* retaining the properties of inertia and weight would remain, *matter*, as we know it, would cease to exist.

Believe me,
Dear Professor STOKES,
Very sincerly yours,
WILLIAM CROOKES.

ON THE COMPOSITION AND ANALYSIS OF THE WELDON MUD.

By Dr. JUL. POST, in Göttingen.

An article by Dr. Lunge, re-published in the CHEMICAL NEWS, vol. xli., pp. 129 and 141, appeared first in *Dingler's Polyt. Journ.* (1880, 235, 300), and has called forth a discussion between us in that magazine, the results of which I wish briefly to communicate as follows.

First of all Dr. Lunge undertakes to defend the process of examining the Weldon mud, in use at most of the works, against me, although I have not only never used a single part of the process, but also have never hitherto expressed an opinion about its worth.

The method of determining oxygen with ferrous sulphate and potassium permanganate has never been brought into use by me in the examination of the Weldon mud. I have tested the matter in the course of some of my synthetical experiments on the voluntary oxidation of manganese, in which the analysis had to be made under the various conditions:—Presence of much free hydrochloric acid, often also of substances which favoured the formation of foam (as saponine, soap, &c.); further, in state of strong concentration and at high temperatures (dilution with cold water would have impaired the accuracy in the presence of such a large quantity of liquid); as to whether, in order to get rid of the filterings, &c., which the Bunsen method makes necessary, the amount of so-called disposable oxygen could not be determined directly in the whole mass with ferrous sulphate solution and re-titration with potassium permanganate solution. I found always by comparison with the results with the Bunsen method that I had used too little permanganate. I attributed and still attribute this circumstance to the presence of considerable quantities of hydrochloric acid principally, because the hydrochloric acid occasioned too small amount of permanganate to be used; but I observed that the pink colour in the titration with permanganate, which in this case was difficult to recognise, disappeared much more rapidly than is usual under normal conditions, and explained this in this way: That the reaction at this apparently stationary point could not have reached its real end, and that a too small amount of permanganate was thus conditioned.

A further objection to my work, namely, that I had worked on specimens changed in their composition through washing with water, is met by the fact that specimens which could not have been changed in this way gave the same results. In an exact analysis made for theoretical purposes, through which we will ascertain the composition of the solid particles suspended in the calcium chloride solution, it does not appear to me sufficiently reliable to measure the mud off as such with a 5 c.c. pipette, as Dr. Lunge did, and then to make the different determinations in the specimens taken in this way. I am sustained in this opinion by the judgment of others (CHEMICAL NEWS, vol. xli., p. 179). We should take larger quantities of the specimens, filtered off and dried over sulphuric acid in analysis, and thus exclude very small values, and which cause inaccuracies. If we take larger specimens of the mud (25 c.c., for example), the larger bulk of precipitate (of chloride of silver) which has to be separated out, causes an inaccuracy, because of the difficulty of washing it out perfectly. After I had satisfied myself of this, I analysed only such specimens from which the $CaCl_2$ solution had been filtered off. The specimens in this condition were so difficult to dry and to weigh (over sulphuric acid) on account of the large amount of $CaCl_2$ they still contained, that I then washed them for a short time with cold water (as described in my article in the *Verhandlungen des Vereines für Gewerbfleiss*), that is, only so long that the wash-water and precipitate (1·8 per cent, as the analysis shows, calculated for dried substance) still showed $CaCl_2$. There is then no occasion for reproaching me with having examined a substance changed through treatment with a 5000 fold quantity of water. I shall, in what follows, in order to remove all pretext, make these specimens alone the basis of remark.

There can be raised against the result of my analyses only one sort of objection—the methods used must be declared impracticable, or the work must be characterised as inexact. In order to meet the last objection, I have always made several analyses of similar specimens. When it is remembered that with the specimens containing calcium chloride a varying amount of water was not to be avoided, and that with the heated specimens the manganese peroxide, &c., must have varied according to the degree of the heating, the results agree satisfactorily among each other. As regards the methods, Dr. Lunge believes that the method of separating manganese and calcium with bromine, which I used, is very inexact. Under the circumstances, I had to choose between this method and the method with ammonium sulphide, as the other methods were first brought forward during and after my publications were made. Dr. Lunge gives the ammonium sulphide method the preference. This method is open to two errors.

Lime is precipitated very easily and manganese dissolved. One can correct the first error by repeated precipitations, but the second error grows thereby, while the amount of lime precipitated in the separation with bromine is so small that this process is in extensive use here in Germany, especially among metallurgists. The opponents of the method agree too that the error can be corrected by repeated precipitation, that is, with similar proportions as those in the regeneration-products in the Weldon process, viz., much manganese and very little lime. I have, moreover, in order to make this matter clear, weighed out manganese as carbonate, and calcium as calc spar, in proportions which corresponded nearly to those in which I had found the two elements in the Weldon mud. The separation was then made in exactly the same way as in the analyses under discussion. Analyses made by myself and others established the high degree of accuracy of this process for the given proportions (see Analyses in *Dingler's Polyt. Journ.*, 236, 228).

Should there be any doubt further as to whether my statement of the low lime content is right, this can be proven directly from the analysis communicated by Dr. Lunge himself; that is, supposing that he separated the lime and manganese quantitatively, and that the mud contained no alkali (as is often the case). It results from this analysis that the lime found there, although, as Dr. Lunge himself says, an abnormally high amount of "base" was present, does not even suffice to combine the hydrochloric acid, carbonic acid, and sulphuric acid found; that, then, no trace of CaO could have been present. We must suppose that the largest part of the magnesium present in the Weldon mud was combined with oxygen, and that, consequently, the lime was united with the acids present. Since, first, in the lime used the Mg is without doubt present in the form MgO alone, and, secondly, the $MgCl_2$ dissolved in the manganous chloride solution is precipitated by the lime when added, and only the small amount present in the end solution, in case the charge has not lime enough to complete the precipitation, can as $MgCl_2$ come in question.

Dr. Lunge lays apparently great weight upon the proportion of MnO_2 to "base." Regarding this, the objection relative to the inexact separation of manganese and calcium would not come into question. A too small amount of lime would correspond to too high a content of manganous oxide. In calculating the amount of manganese from the weight of Mn_3O_4 found, and the calcium from CaO, we multiply by nearly the same fraction (about $\frac{4}{7}$), so that the result does not experience any essential change in this way.

Finally, Dr. Lunge attacks my analyses by saying that "according to his knowledge" specimens with so low proportion of "base" as I have found do not occur in the practice. This appears to me incorrect, because the varying composition of the products of the Weldon process is caused chiefly by the different content of MnO; in other words, the varying degree to which the oxidation is carried in the process. It is clear that the oxidation must go forward most rapidly at first, that it then becomes slower and slower until finally a point is reached where the continuation of the process does not pay, and where it is broken off before probably the theoretical completion of the reaction has been reached. I have heard often from the managers that the final gain of "disposable oxygen" has been increased by the improvements in the process with time. The content of "base" must have decreased them.

When my results are expressed in the same terms as those in which the results of the Weldon method of examination are usually expressed,—that is, when the carbonic acid present is left out of account—the variation of proportion of MnO_2 to "base" from that assumed as the normal by Dr. Lunge is very small. In one of the two analyses of mud, only a little washed with cold water—to which the objection of a change in composition cannot be applied—there was found:—36·51 per cent MnO_2, 6·72 per cent MnO, 3·02 per cent Ca, 0·58 per cent Mg, 0·60 per cent Fe_2O_3, 1·41 per cent CO_2, 0·59 per cent Cl, 0·14 per cent SO_4. After deducting the amount of calcium required by the chlorine and the sulphuric acid there remains 2·63 per cent. These require, in order to satisfy the Weldon formula, 11·44 per cent MnO_2, the manganous oxide requires 16·47 per cent MnO_2, the magnesium oxide 4·20 per cent MnO_2, the iron sesquioxide 1·305 per cent MnO_2. There is required thus a total of 33·42 per cent MnO_2: 36·51 per cent, or 3·09 per cent more was found. Now, when for 36·51 per cent MnO_2 3·09 too much was found, the proportion for 1 part of MnO_2 is 0·0846 too much MnO_2; the proportion of MnO_2 to "base" is here, therefore, 1·0846 to 0·50, or 1 to 0·46.

Dr. Lunge draws conclusions from my results against which I tried to guard myself in advance in each of my publications on this subject, by repeatedly laying stress on the fact that a conclusion as to the question about the existence of a "manganous" acid and its salts could only be reached after the completion of synthetical experiments, with which I am still occupied. It is understood, of course, that with this expressed reservation the proposal of provisional theories is not only admissible but requested. How can a leading line for the further necessary investigation be found and fixed otherwise? The circumstance that only a small amount of CaO is present in the Weldon mud suggests the question, What becomes of the so-called excess of lime which is added? According to information I have received this excess is equal to one-half of the amount necessary for the precipitation (one-half is added immediately after the precipitation, and about one-half of this is carried off in the end solution). This led me to the conjecture, which I afterwards established in reality, that the precipitated $Mn(OH)_2$ still contains chlorine, which takes up the so-called excess of lime in the process. Still I cannot regard the circumstance as fully explained herewith. The quantity of chlorine present does not appear by any means sufficient to neutralise the excess.

The conclusions which it appears to me can be drawn with certainty from my experiments as far as completed, and which, too, have found only support through the criticism here discussed, can be grasped together in these two propositions:—(1) In the mud, even when there is an unusually large content of the so-called "base," there is too little lime (CaO) present for the admission of the theory that the mud consists essentially of a calcium manganite, $CaO(MnO_2)_2$. (2) A mud also now occurs in the practical working of the Weldon process, in which the content of "base" lies under 0·5 (where $MnO_2 = 1$).

As regards the "thick batches," whose production was discussed at a recent meeting of the Newcastle Chemical Society (Chemical News, vol. xli., p. 179), I will note briefly here in addition my observation (a detailed report will be made soon), that the formation of the "thick batches can be prevented and a satisfactory result obtained without an excess of $CaCl_2$ if the milk of lime (the "excess") is added very slowly in very small amounts, according to the weakening of the alkaline reaction in the filtrate. They never proceed in this way in the works to be sure, because an excess of $CaCl_2$ hinders the formation of the "thick batches" without causing the slightest inconvenience. It appears that they always proceed in this way here on the Continent, and they never experience any "thick batches." An experiment in a large model apparatus (made after the Weldon pattern) made at the ordinary temperature (and without excess of $CaCl_2$) yielded the "thick batches" likewise.

Göttingen, May 15, 1880.

Alkalies in Æthusa Cynapium.—W. Bernhardt.—Cynapine was first obtained from this plant by Ficinus; it is a yellowish red oily liquid, with a strongly alkaline reaction and a very penetrating aad offensive odour. Qualitative examination showed the presence of nitrogen. —*Arch. Pharm.*

SOME REMARKS ON SIEMENS-MARTIN STEEL.

By SERGIUS KERN, M.E., St. Petersburg.

The chief steel works in Russia are situated near St. Petersburg. The Obouchoff Steel Works have erected lately two 10-ton Siemens-Martin furnaces. The furnaces have no muffles for heating previously the charges introduced into the furnace, and the mode of working adopted here differs from the Terre-Noire method, as described by Mr. A. L. Holley. The author desires to give a short description of the *modus operandi* and a full account of some charges. The charge consists of steel scrap, ladle scrap, and manganese pig-iron. A pig containing 9 to 12 per cent of manganese is ordinarily used. It is well known that big cast-steel ingots have a piping in their top part; and as such a part is of no use for forgings, therefore a certain part of the ingot, when forged into the required shape, is always cut off under the steam hammer. Such ends are also used for the Siemens-Martin furnace. Very often ends weighing about 2 to 2½ tons are introduced among other steel scrap in the cold state into the furnace. During the process of charging the furnace is kept as hot as possible. All the required materials, viz., pig-iron, steel scrap, and ladle scrap (about 8 tons altogether) are charged at once, and no additional charges are introduced after the metal is in a melted state, save if the testing of a sample out of the furnace shows that the metal is too hard; then, ordinarily, some 15 to 20 cwts. of good puddled iron blooms are introduced into the metallic bath. The blooms are left for some time on the banks of the furnace doors, and when well heated are thrown down into the metallic bath. But it has been found to be cheaper and quicker, in order to soften the metal, to introduce some 2 to 5 cwts. of good magnetic iron ore in the form of a fine powder. The steel tests taken afterwards soon show that the steel has turned mild; but if it happens that even then the steel is not so soft as desired, another charge of 3 to 4 cwts. of magnetic ore with 1 cwt. of ferromanganese quickly brings the steel to the desired softness. Certainly, much depends on the state of the gas and on the quality of the materials, but with a well-going furnace and good materials the above holds good.

Before the casting, if soft steel is wanted, ½ to 1 cwt. of ferromanganese is added, and for harder steel, containing 0·50 to 0·65 per cent of carbon, often 3 to 10 cwts. of spiegeleisen is the additional charge. As there is no handy direct process to ascertain the amount of carbon in the samples taken out of the furnace, the engineer is often in a difficulty in calculating the amount of the last charge of ferromanganese or spiegeleisen to be introduced into the metallic bath. A very good test is the following:—The sound part of a sample is heated to light welding heat, and hammered to the following dimensions (approximative): 5″ × 0·5″ × $\frac{5}{16}$″. This small bar cooled slowly in ashes, or sand, must bend nearly double, and if it stands the test tolerably well it may be supposed to contain not more than 0·25 to 0·30 per cent of carbon. The sample after being drawn, by hammering before being cooled, as mentioned above, must be re-heated to a red heat.

The following charges give an idea of the mode of working:—

Hard Steel.—Charge: steel scrap, 120 cwts.; ladle scrap, 17 cwts.; pig-iron, containing 12 per cent of manganese, 17 cwts.; all charged at once; charging commenced 4.30 a.m., finished 6 a.m. Melted, and one sample taken out 8.15 a.m.; 17 cwts. puddled iron blooms charged 9 a.m.; sample hammered well, cooled, bent double; 15 cwts. pig-iron, containing 9 per cent of manganese, charged 10.20 a.m.; casting took place at 11 a.m. Analysis of the steel: carbon, 0·67; manganese, 0·40 per cent.

Medium Steel.—Charge: steel scrap, 135 cwts.; ladle scrap, 23 cwts.; pig-iron, containing 12 per cent of manganese, 10 cwts.; charging commenced 1 p.m., finished 2.45 p.m.; melted, 0·5 cwt. ferromanganese added, and first test taken 7.40 p.m. The steel was hard. 2·5 cwts. of magnetic iron ore added 7.55 p.m. Test taken 8.30 p.m.; sample bar bent nearly double, giving only a slight crack. 0·5 cwt. of ferromanganese added. Casting 9.15 p.m. Analysis of the steel: carbon, 0·35; manganese, 0·18 per cent.

Soft Steel.—Charge: steel scrap, 113 cwts.; ladle scrap, 26 cwts.; pig-iron, containing 12 per cent of manganese, 6·5 cwts.; charging commenced 11 a.m., finished 12.30 p.m. Melted, and first test 6 p.m.; 2 cwts. ferromanganese added 6.30 p.m.; test bar bent double, after being hardened; ⅛ cwt. ferromanganese added 7 p.m.; casting, 7.15 p.m. Analysis of the steel: carbon, 0·16; manganese, 0·14 per cent. The steel was prepared for boile plates.

ANALYSES OF SOME HAIR-DYES.

By J. F. BRAGA.

Being solicited to ascertain for some clients in Portuga the general composition of the various hair-dyes largely sold, and I suppose used, in England, I have from time to time submitted specimens to analysis; the results may be of some interest to your readers.

The dyes may be classified as those for making the hair dark, and those for making it light, though this latter operation consists in bleaching, not dyeing, the hair.

For making the hair light I have found that the material used is peroxide of hydrogen, sold under numberless fanciful names, and usually at extravagantly fanciful prices. It is perfectly harmless to the hair, its action being limited apparently to the oxidation of the colouring-matter. It appears to be without action upon "red" hair, other materials, such as permanganate of potash, dilute nitric acid, and strong ammonia, exercising a more or less bleaching effect, and, though destructive to the hair, have been sold; but they appear to have been completely displaced by the peroxide of hydrogen.

The substances used for making the hair dark, the true dyes, seem, so far as my experiments go, to be limited to solutions of lead, silver, and copper.

Of the lead solutions, that of the hyposulphite is about the best. I found the sample I analysed had been prepared by mixing acetate of lead with an excess of hyposulphite of soda, the solution containing glycerin and a little alcohol. After accurately determining the amount of lead, and approximately the amounts of the other constituents, I successfully imitated the original by the following formula:—

Acetate of lead	5·7 grms.
Hyposulphite of soda..	11·5 grms.
Glycerin	50·0 c.c.
Spirits of wine	100·0 c.c.
Distilled water	850·0 c.c.

The salts being separately dissolved, and the glycerin and alcohol mixed with the hyposulphite, the solution of lead was then gradually poured into the mixture. The resulting compound should be kept in the dark.

Another consisted simply of a solution of oxide of lead and glycerin, with precipitated sulphur in suspension; its composition being:—

Oxide of lead	17·0 grms.
Glycerin	300·0 grms.
Water..	to 1 litre
Precipitated sulphur.. ..	17·0 grms. in 1 litre

A third closely resembled this, being composed as follows:—

Acetate of lead	12·5 grms.
Glycerin	125·0 grms.
Distilled water	to 1 litre
Precipitated sulphur.. ..	10·0 grms.

This was stated to be unsatisfactory in its action. The last which I shall mention of the lead dyes consisted

of a very dilute solution of lead in caustic potash. I was enabled to imitate it after analysis by dissolving 1·25 grms. of acetate of lead in hot water, and adding thereto a hot freshly-prepared solution of caustic potash, until the precipitate at first formed *just* re-dissolved, and then diluting that solution up to 1 litre.

The perfume of these liquids is due to the employment of scented waters, prepared either by distillation, or after an alternative method, such as that given in the "Pharmacopœia."

NOTE ON THE ACTUAL STATE OF THE DETERMINATION OF ZINC.

By W. ALEXANDROWICZ.

The separation of zinc from the metals of the copper and the iron group presents considerable difficulties. The quantity of zinc thrown down along with copper by sulphuretted hydrogen is not appreciable if the solution is sufficiently acid. Where great exactitude is required a double precipitation is recommended.

The complete separation of cadmium and zinc by means of sulphuretted hydrogen is impossible, especially in presence of copper. In separating arsenic from zinc, if the solution is distinctly acid the zinc is not thrown down by sulphuretted hydrogen.

In separating iron and zinc the author recommends that the solution of the mixed metals should be poured drop by drop into the ammonia, and not *vice versa*. The zinc remains in solution. The precipitate is then washed with ammoniacal water.

In separating manganese from zinc the author acidifies with acetic acid and precipitates with sulphuretted hydrogen. All the manganese remains in solution.—*Revue Universelle des Mines.*

THE BEHAVIOUR OF SULPHURETTED HYDROGEN WITH THE SALTS OF THE HEAVY METALS.*

By H. DELFFS.

The author called attention to the different precipitability of the metallic salts in presence of a strong mineral acid an the one hand, and of acetic acid on the other. Just as the limit between precipitable and non-precipitable salts is altered by the use of acetic acid instead of hydrochloric acid, it is further modified if formiates are treated with sulphuretted hydrogen. In that case the salt of zinc is precipitated, but the compounds of cobalt, nickel, iron, and manganese are not affected. Manganese cannot be precipitated by sulphuretted hydrogen from propionic, butyric, and valerianic solutions. In precipitations by this last reagent several metals are never simultaneously converted into the corresponding sulphides, but the precipitation ensues in such a manner that one metal is first completely separated before the removal of another begins. Upon this fact is founded a very convenient method for obtaining cobalt and nickel in a state of purity. As sulphuretted hydrogen first completely precipitates cobalt acetate, and then acts upon nickel acetate, a solution of the two nitrates is mixed with sodium acetate in quantity insufficient for complete double decomposition, and sulphuretted hydrogen is introduced, so that, according to the respective proportions of the two metals, either nickel free from cobalt is obtained in solution or cobalt free from nickel as a precipitate. The required quantity of sodium acetate may be calculated from the relative quantities of the two metals which are mostly known. The more electro-positive a metal the later it is precipitated from a mixture of its salts with those of other metals, and thus a series of "chemical tension" may be established, which, on account of the electromotoric action of the liquids, does not always agree with the series of "physical tension."

* A Paper read before the Chemical Section of the Congress of German Naturalists and Physicians, at Baden-Baden, Sept. 19, 1879.

ON AN AUTOMATIC MERCURIAL PUMP.

By M. G. COUTTOLENC.

This apparatus is a mercurial pump, acting in the usual manner, but without cocks; it can also work automatically and indefinitely with the same quantity of mercury. This pump is only intended to complete the vacuum, and works under a pressure of at most 40 to 60 m.m. of mercury. As will be seen a water pump serves to begin the vacuum, provided it is connected to the apparatus by a desiccating tube. The following is the description of the pump:—A reservoir, capable of a lateral movement of about 0·30 m. is connected with a vertical tube of 0·80 m. At the upper part of the glass tube there is seen first a lateral junction fitted with a valve of a very simple construction, the utility of which will appear further. Immediately above this junction there is cemented a tube of a smaller diameter (0·25 m.) plunging into the former. To this second tube is blown a reservoir pump-body of a suitable form, and at the lower part of this is a tube of 0·002 m. in diameter, which forms an elbow and rises perpendicularly, extending some centimetres past the reservoir, where it has an enlargement, and leads at last to the receiver to be exhausted. The upper part of the reservoir pump-body ends in a very fine glass tube ($\frac{1}{4}$ to $\frac{2}{3}$ millimetre in internal diameter), which re-descends parallel to the reservoir after a double elbow, and plunges into a small vessel fixed close by. The end of this tube and the vessel are inserted and cemented into a glass reservoir communicating on the one hand with the water-pump, and on the other with the valve mentioned at first.

When thus fitted up the apparatus works as follows:—The gas of the instrument being once rarified by the water-pump, the mercury rises in the vertical tube sufficiently to isolate the two concentric tubes. If, at this moment, the movable reservoir is raised up, the mercury ascends first into the lateral junction, where it is soon stopped by the valve, and at the same time into the interior tube; passing before the narrow tube leading to the receiver to be exhausted the mercury closes it and fills the reservoir pump-body, driving out the residual gas by the upper capillary tube. Here it chokes the pipe, returns into the small vessel, and the excess falls on the side of the second reservoir above the valve. If, in the meantime, the movable reservoir re-descends, the mercury will leave in the fine tube a column sufficient to close it, and then retiring from the reservoir pump-body it produces there a barometric vacuum, which is placed in connection with the receiver to be exhausted, when the mercury unstops the tube leading to it. But at the same time when this effect is produced the mercury, which had fallen into the other reservoir above the valve, returns into the outer tube. If the movable reservoir is then raised again, the same effects are re-produced, and each time the receiver to be exhausted is brought in connection with the barometric vacuum. The pump works, therefore, by means of a simple up and down movement, which is easily obtained from any source of power.—*Comptes Rendus.*

Melting-points of Minerals and Metals.—A. Schertel.—The determinations were made with the aid of Prinsep's alloys. The melting-point of nickel was found to be 1392° to 1420°.—*Berg. u. Hütten Zeitung.*

ON THE ELECTROLYTIC DETERMINATION OF METALS.

By LUDWIG SCHICHT.

The author's researches refer to the metals of the group uranium, thallium, indium, and vanadium, and to the group molybdenum, selenium, and tellurium. Uranium is not precipitated from its solutions in mineral acids, but by the secondary action the effect of the nascent hydrogen uranic oxide is reduced to uranous oxide. From neutral solutions it is separated in very small quantities, of a yellow colour. Alkaline solutions containing organic acids (tartaric, citric, acetic), or mixed with sugar, deposit likewise very small quantities of uranium. The precipitated uranium does not readily re-dissolve in dilute acids. Sulphuric and nitric solutions of thallium were prepared from the pure metal. The acidulated solutions were not precipitated by the current. From ammoniacal solutions metallic thallium was deposited at the cathode with a brisk disengagement of gas, whilst at the positive pole there appeared blackish brown thallium oxide, much resembling lead peroxide. For the deeomposition, the author used at first the current from 4 Meidinger Pincus elements, giving hourly 160 c.c. of detonating gas, but this was found too strong, as the thallium was deposited in a spongey state and of a darker colour. On using 2 or 3 elements fine, permanently adhesive metal was obtained. From neutral solutions the metal is imperfectly precipitated on account of the acid which is liberated. In alkaline solutions the separation is complete and the metal is bright and solid. It re-dissolves readily in sulphuric acid. The oxide dissolves in hydrochloric acid, evolving chlorine. Indium is completely precipitated as metal at the negative pole, both from acid and alkaline solutions; in the latter case the metal is very bright and firm.

Vanadium.—Vanadium chloride was dissolved in water containing hydrochloric acid and electrolysed. No precipitation took place in the blue solution, the vanadic acid being merely reduced to oxide. Sulphurous acid, organic acids, &c., reduce merely to vanadium tetroxide, V_2O_4. The same reduction occurs in the alkaline solution.

Palladium.—The nitrate, dissolved in water and acidified with a little nitric acid, deposited at the negative pole a bronze-coloured coating, which on continued action of the current became darker and finally black. It re-dissolves easily in nitric acid. Some reddish oxide was formed at the positive pole. Alkaline solutions of palladium behave in a similar manner, but the deposition is slower and more adhesive.

Molybdenum is precipitated from the ammoniacal solution of molybdic acid as molybdous oxide, which appears at the negative pole at first in coloured rings, which gradually thicken and become blue-black. The first blue precipitation is molybdic molybdate; then follows molybdic oxide and molybdous oxide. The precipitation is complete and adheres very firmly. In acid solutions there is no precipitation; in ammonium molybdate acidified with free molybdic acid the precipitation is imperfect.

Selenium is readily and completely reduced and thrown down, both from acid and alkaline solutions. The current should not be strong (2 elements) or the deposit is pulverulent. In order to determine selenium electrolytically it is oxidised by boiling with nitric acid, and the solution of a metal is added, which occasions the separation of the selenium in a solid combination. A solution of copper is suitable for this purpose.

Tellurium behaves like selenium, but it is reduced much more readily. From an acid solution it is easily deposited with a blue-black colour. From alkaline solutions it is thrown down in a very loose state at the positive pole, with strong disengagement of gas. If much metal is present it floats on the surface of the liquid.

Gallium, like zinc, is thrown down completely at the negative pole in a pure state.—*Berg. und Hüttenmännische Zeitung*, 39, p. 121.

DETECTION AND DETERMINATION OF CHLORINE IN PRESENCE OF BROMINE AND IODINE

By G. VORTMANN.

The author has discovered a method by means of which even small quantities of chlorine along with the other halogens can be easily and quickly detected. It depends on the different behaviour of the chlorides, bromides, and iodides with peroxides of manganese and lead in presence of acetic acid.

Iodides are partially decomposed by the above-mentioned peroxides, even in neutral solutions, and if they are boiled with the addition of acetic acid the iodine is completely eliminated. Lead peroxide oxidises a part of the iodine to iodic acid, but with manganese peroxide no iodic acid is formed.

In a neutral solution bromides are not decomposed either by manganese- or lead-peroxide. In an acetic solution the lead peroxide only acts, bromine escapes, but bromic acid is formed only if bromides are present in considerable quantities. Manganese peroxide has no action in the acetic solution, even on prolonged heating.

Chlorides are not attacked by either of the peroxides in presence of acetic acid. In testing for chlorides in presence of bromides or iodides it is sufficient to boil the substance in an acetic solution with lead peroxide till the liquid on settling is colourless, and has not the slightest odour of bromine or iodine. The bromine and a part of the iodine escape as such; the remainder of the iodine remains as lead iodate along with the excess of the lead peroxide. On filtering and washing the precipitate, all the chlorine is found in the filtrate free from bromine and iodine. In this manner the chlorine may be determined quantitatively. If the quantity of chlorine accompanying the iodine is considerable, manganese peroxide is preferable to lead peroxide, as otherwise the liquid must be largely diluted with water to prevent lead chloride from depositing. In determining large quantities of chlorine in presence of bromine, it is well to add along with the lead peroxide some potassium sulphate so that all the chlorine may be found in the filtrate combined with potassium.

In order to expel the liberated bromine and iodine more rapidly a moderate current of air may be passed through the solution on the water-bath.—*Berichte der Deutschen Chem. Gesellschaft.*

NOTICES OF BOOKS.

Potable Water: How to form a Judgment on the Suitableness of Water for Drinking Purposes. Addressed to Medical Officers of Health and Sanitary Authorities. By Charles Ekin, F.C.S. London: J. and A. Churchill.

We have here a small but sensible book on a subject which, though it has often been enquired into, is not yet exhausted. The author points out that when sitting in judgment upon water we have to deal not so much with facts as with the conclusions to be drawn from those facts, and that the question of the probable physiological action of a water is rather one of medicine than of chemistry. How is it, we may here ask, that the medical profession had no representative in the second Rivers' Pollution Commission?

On the suitableness of rain-water for domestic uses we agree with Mr. Ekin rather than with the Commissioners. We have known persons who have used it for years and who have been totally free from zymotic disease. The impurities in the upper regions of the air where rain condenses are doubtless slighter than in the strata nearer the ground. In prolonged rains the atmosphere is washed by the first downfall, and the subsequent supply will be practically pure.

Certain inconsistencies of the Rivers' Pollution Commissioners are skilfully touched upon. We all know to what an extent these authorities are enamoured of sewage irrigation and "intermittent downward filtration." In a passage quoted by Mr. Ekin they declare, speaking of certain water near a churchyard, that "the exhaustive filtration to which it had been subjected in passing downwards through so great a thickness of material, and the rapid oxidation of the dissolved organic matter in a porous and aërated medium, afford considerable guarantee that all noxious constituents had been removed." Yet elsewhere they say that "though the purification of water polluted by human excrements may reasonably be considered to be some safeguard against the propagation of epidemic diseases *there is not in the form of actual experience a tittle of trustworthy evidence* to support such a view." They also quote the case of the epidemic of typhoid at Laussen to show that filtration through a mile of earth and rock does not keep back disease germs.

The real question, as Mr. Ekin very judiciously points out, is not so much the quantity as the quality of the organic matter present in water. Carbon, nitrogen, &c., may be derived entirely from innocent matter, or wholly or partially from some very dangerous source, and no organic analysis will *per se* solve the difficulty. The author differs from Professor Wanklyn in considering that the presence of nitrogen as nitrates in quantities exceeding 0·3 per 100,000 should be regarded as an unfavourable symptom, even if little organic matter is present, and that if the proportion reaches 0·9 to 1·1 it warrants condemnation. This view, Mr. Ekin remarks, was forced upon him by experience in spite of a bias in a contrary direction. Of chlorine he is also strongly suspicious, excepting in coast localities, and of course in districts where salt-springs occur. It will be remembered that according to Dr. Tidy water for drinking purposes should not require more oxygen to burn up its organic matter than from 0·05 to 0·15 parts per 100,000, whilst if the amount rises to 0·21 part the water is doubtful, and if higher it is to be condemned. On this view Mr. Ekin observes that "in the case of an infected water six typhoid germs are harmless, whilst nine would be hurtful."

The microscopic examination of water and the determination of phosphates the author has purposely avoided, considering that "in the present state of our knowledge they afford only additional evidence where the evidence is already complete." We can scarcely agree with this view: the microscope is surely calculated to inform us as to the nature and origin of the organic matter present, and phosphoric acid is surely a safer guide than chlorine, which occurs more frequently in nature in a soluble state without being traceable to animal pollution.

On the Properties, Preparation, and the Uses of Methyl Chloride. Lille: Ducoulombier.

Methyl chloride, or the hydrochloric ether of methylic alcohol is represented by the formula $C_2H_3Cl=50·5$. It is gaseous at common temperatures, possesses an etherial odour and a saccharine taste; its specific gravity is 1·738 (air=1·0 at 0°). The weight of a litre of this gas=2·261 grms. Water dissolves 2·8 vols. methyl chloride at 16° and under a barometric pressure of 0·765. Glacial acetic acid dissolves 40, and absolute alcohol 35 vols. under the same conditions. Methyl chloride burns with a white flame edged with green, forming water, carbonic acid, and torrents of hydrochloric acid gas. If methyl chloride is compressed, it is easily converted into a colourless and highly mobile liquid boiling about −23° under the normal pressure of 0·760 m. The slight vapour tension of this product renders its liquefaction, its management, and its carriage easy. Thus the total tension of its vapour is at—

0°	.. ..	2·48 atmospheres.
+15°	.. ..	4·11 ,,
20°	.. ..	4·81 ,,
25°	.. ..	5·62 ,,
30°	.. ..	6·50 ,,
35°	.. ..	7·50 ,,

From these figures, one atmosphere must be deducted to find the pressure really exercised upon the vessels containing the liquid.

Hitherto chloride of methyl, as prepared by the mutual reaction of common salt, sulphuric acid, and methylic alcohol, has not been suitable for industrial applications on account of the difficulty of preparing it in a state of purity at a moderate price. Quite recently M. Camille Vincent has made known a process which enables it to be procured in abundance and free from impurities.

This process consists in heating the hydrochlorate of tri-methylamine which is obtained industrially from the refuse of beet-root. The hydrochlorate of tri-methylamine is thus decomposed into free trimethylamine, ammonia, and methyl chloride. Washing in acid water removes every trace of alkali, and the dried gas may then be liquefied by compression. The product thus obtained, perfectly pure, is manufactured on the large scale by MM. Brigonnet and Son, at Saint Denis.

Uses of Methyl Chloride.

As a frigorific agent, methyl chloride may be employed either in the laboratory or in manufactures. If it is allowed to issue into an open vessel, it enters into a brisk ebullition for a few moments. Its surface then becomes tranquil, forming a bath at −23°, into which the objects to be refrigerated may be plunged. If the evaporation is intensified by the injection of dry air, the temperature of the bath may be reduced to −55° in a few minutes, so as to freeze mercury. M. Vincent has designed a small apparatus for the laboratory in which a bath of 1 litre of an incongelable liquid (*e.g.*, alcohol) may be kept for some hours at a temperature of −23°, or of 50—55°. It is composed of a cylindrical vessel of copper with double walls.

M. Vincent has also constructed a more complete apparatus, suitable either for experimental or domestic purposes, and so arranged that the methyl chloride may be recovered. Large machines are also made adapted for cooling water, air, &c., on the great scale. They have the advantage of employing, as vehicle of heat, a neutral liquid incapable of attacking metal work and free from poisonous or offensive unexplosive properties.

It must be remembered that the chloride of methyl can be used in any machine for the production of ice with the exception of those constructed to work with liquid ammonia.

Preparation of Methylic Products.

Methyl chloride is a product which offers great advantages to the manufacturers of colouring-matters derived from coal-tar. It may serve in the manufacture of coloured or colourable products in which methyl plays any part soever, such as methylaniline, methyldiphenylamine, methyltoluidin (which yields a red-violet, Hofmann's violet, methyl-green, methylic eosin, &c.).

It is an advantageous substitute for the other methylic compounds commonly employed, such as methyl bromide, iodide, and nitrate, the two former of which are costly and the latter dangerously explosive. Liquefied methyl chloride being a pure and anhydrous compound is well adapted for exact operations which lead to perfect regularity in the quality of the product.

The methylated compounds which have been already prepared with liquid methyl chloride are, dimethylaniline, methyldiphenylamine, Hofmann's violet, and methyl-green. We will briefly describe the preparation of the two latter according to the process of MM. Monnet and Reverdin, of Laplaine, near Geneva.

To obtain green with methyl chloride, we place in an autoclave a solution of methylaniline violet in methylic alcohol rendered basic by the addition of soda. The apparatus is closed and a known quantity of methyl chloride is introduced by means of the manipulation already described. The autoclave is placed in a water-bath heated by a jet of steam and the temperature is raised to 4 or 5 atmospheres. When the reaction is complete, the hot water is let out and its place is taken by a stream of cold

water, the excess of pressure being destroyed by slackening the screw of the cock.

The produce of the reaction is heated with an alkali and filtered to separate the base of the violet: the filtrate containing the base of the green is treated with an acid and a salt of zinc to form the corresponding double salt of the green and of zinc, and the colouring matter is then precipitated by common salt. By substituting in the preceding operation rosaniline for methylaniline violet we obtain Hofmann's violet.

A Course of Qualitative Chemical Analysis. By the late W. G. Valentin, F.C.S. Revised and Edited by W. R. Hodgkinson, Ph.D., &c. Fifth Edition. London: J. and A. Churchill.

Mr. Valentin's character as a meritorious and successful teacher of chemistry was widely and justly appreciated, and the work before us in its various editions has been prized by several generations of students. But the question may, we submit, be fairly raised whether a treatise on analytical chemistry is the proper place for a consideration of nomenclature and notation, and whether the formulæ which occur here in such profusion are necessary, or even beneficial? What bearing, for instance, has the graphic formula of magnetic pyrites, otherwise pentaferrous diferric octasulphide, on the recognition of iron in its combinations? It seems to us that this matter must in a manner mask the really essential portions of the work, whilst they greatly increase its bulk and add to its cost. The reactions of the rarer metals are given as an appendix—a judicious arrangement, since it prevents the beginner from being overwhelmed in the outset with a multitude of elements, and enables him to proceed from the easier to the more complex and difficult parts of the subject.

Price List of Dr. Theodor Schuchardt's Chemical Works, Goerlitz. Summer Half-year, 1880.

A most extensive and complete catalogue of chemicals, including many of the rarest kinds. The prices are given both in German and in French money. It is a curious feature that, with few exceptions, the various compounds are made to figure under Latin names, by which they are known merely to pharmaceutists. In addition, the catalogue includes chemical apparatus and collections of specimens for a variety of purposes. Among these may be mentioned sets of phosphorescent bodies; a collection of preparations for spectroscopic examination; a collection of alkaloids; physiological preparations, both animal and vegetable; a set of 68 coal-tar colours and intermediate products, accompanied by specimens of dyed tissues; collections illustrative of crystallography; a set of 40 minerals from Vesuvius, &c.

On Shoyu. By T. Isono. Tokio: The Department of Science.

"Shoyu" is a liquid formed by the fermentation of a mixture of beans and wheat in a saline solution, and appears to play a very important part in Japanese cookery. It contains glucose, dextrin, small proportions of alcohol and acetic acid, and 1·43 per cent of nitrogen in organic combination.

The treatise contains an account of the salt works of Japan, which at present use sea-water as their raw material.

Non-poisonous Colours.—The following colours are officially sanctioned by the Public Health Department for use in confectionery, &c.:—For white, flour and starch; for red, cochineal, carmine, madder-red, and the juice of carrots and cherries; for yellow, saffron, safflower, and turmeric; for blue, indigo and litmus; green, juice of spinach and mixtures of the above blues and yellows; for brown, burnt sugar and Spanish juice, and for black, Indian ink.—*Reimann's Farber Zeitung.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 19, May 10, 1880.

Crystalline Form of Magnesium,—M. des Cloizeaux.—The normal form of these crystals is a regular hexagonal prism terminated by a base rather less brilliant than the lateral faces. Among the rhombohedric metals magnesium next to zinc affords the most acute primitive form. The crystals are very malleable and sectile, and no cleavage was observed.

Experimental Researches on the Decomposition of Certain Explosives: Analysis of the Products.—MM. Sarrau and Vieille.—Under a pressure differing little from that of the atmosphere all the explosives experimented upon gave different results from those obtained under strong pressure (see *Comptes Rendus* for May, 1880). All yielded nitric oxide and carbon monoxide. Pure gun-cotton and nitro-glycerin evolved C_2H_4.

Theory of the Phenomena of Interference where Rotatory Polarisation Intervenes.—M. Gouy.—A mathematical paper, not admitting of useful abstraction.

Equipotential Lines of a Plane formed of Two Halves of Unequal Conductibility.—A. Guébhard.—This memoir requires the accompanying diagram.

Mutual Action of Magnetic Needles Plunged into Liquids.—M. Obalski.—The needles approach each other by their submerged portion. If the level of the liquid is raised the mutual approach becomes more distinct, and when the third or the fourth of the needles is submerged they rush into contact.

No. 20, May 17, 1880.

On Saccharin.—E. Peligot.—Saccharin is dextro rotatory, like common sugar, with which it agrees in percentage-composition. Its rotatory power is represented by 93·5°; that of sugar with the same apparatus and under the same conditions belng 67·18°. The essential characteristic of saccharin is its relative stability and inertness as regards the reagents which act in a special manner on the group of sugars. It does not ferment; it is volatile almost without decomposition; it does not reduce that alkaline copper tartrate solution, and it is not transformed into fermentible sugar by prolonged ebullition with sulphuric acid. It is not attacked by a hot and concentrated solution of caustic potassa.

Researches on the Proportion of Carbonic Acid in the Air.—J. Reiset.—The apparatus used by the author cannot be described without the accompanying cuts; it is a modification of that used by Schlœsing for the determination of atmospheric ammonia. He finds in 100,000 parts of atmospheric air, 29·78 parts by volume, the greatest differences observed only reaching hundred thousandths. The air in the night contained more carbonic acid than in the day. The maxima observed correspond to foggy weather. He has not detected any decrease in the proportion of carbonic acid as a weather indication.

The Tensions of Saturated Vapours have Different Methods of Variation according as they are given off above or below the Point of Fusion.—M. Paul de Mondesir.—The author's observations prove, in his opinion, that the passage of the fusion-point involves a very marked change in the mode of variation of the tensions. Whether this change results really from the physical phenomenon or from the presence of foreign bodies, or from isomeric changes, the conclusion remains that vapours given off by a liquid must be distinguished from vapours given off by a solid.

Refrigerating Mixtures formed by an Acid and a Hydrated Salt.—A. Ditte.—In this case the refrigeration is not due to a simple solution of the salt; there is always a double decomposition in conformity with the law of maximum work. The fall of temperature observed springs from the circumstance that the salts employed contain a large quantity of water, which takes no part in the reaction, but is separated from the solid hydrated salt, of which it formed a part, and the result is as if it became liquid. This change of state absorbs the heat which the reaction liberates, and borrows from the liquid itself the surplus of *vis viva* necessary for its completion. Hence results a considerable reduction of temperature.

Variations of Urea in Cases of Phosphoric Poisoning.—M. Thibaut.—At the outset of the experiments the daily secretion of urea was 15·66 grms.; it fell afterwards to 5·77 grms., rose again to 11·59, and sank finally to 0·20 grm. As the urea diminished in the urine it increased in the blood. The proportion of urea in the liver was also increased. The liver seems the principal focus for the production of urea.

Influence of Fattening Animals upon the Constitution of the Fats formed in their Tissues.—A. Muntz. As animals are fattened, their fats become more fusible and contain a smaller proportion of solids. Hence they possess a lower industrial value.

Fixity of the Composition of Plants: Analysis of Soya hispida.—H. Pellet.—In specimens of soya grown respectively in China, Hungary, and France, the proportions of phosphoric acid and potash, which together constitute three-fourths of the ash, fluctuate very little. There is rather more variation in the soda, lime, and magnesia.

Chemiker Zeitung.
No. 13, 1880.

Azo and Naphthol Colouring-matters.—G. Auerbach.—The first part of a memoir, in which the author describes the preparation of this class of colours, but shows that few of them have become of real commercial importance.

Die Chemische Industrie.
No. 2, February, 1880.

Formation of Graphite by the Decomposition of Cyanogen Compounds.—W. Thalheim.—The author maintains that the graphite which appears during the preparation of caustic soda from the mother-liquors of the Leblanc process is due, not, as supposed by Pauli, to the destruction of cyanogen compounds, but is extracted out of the cast-iron pans. If the lye is concentrated and the sulphur compounds oxidised in a silver capsule no graphite is deposited.

Apparatus for Testing Petroleum.—C. Engler.—This paper cannot be reproduced without the accompanying illustrations.

The Production of Glycerin.—The total annual production of glycerin in Europe is 9 million kilos., 4 millions of which fall to the share of France. England yields merely 300,000 kilos.

Valuation of Reverted Phosphoric Acid in Manurial Phosphates.—At the congress of directors of agricultural experimental stations, held in September last in Carlsruhe, Prof. Petermann gave a detailed account of the reasons which induce him and his Belgian colleagues to value phosphates soluble in ammonium citrate as highly as those soluble in water. He explains that the phosphates of commerce which have been treated with sulphuric acid may contain phosphoric acid, either as free hydrated acid, as mono-calcium phosphate, as dicalcium phosphate, as neutral iron phosphate, as neutral aluminium phosphate, as tricalcium phosphate which has escaped the action of the sulphuric acid, and lastly as tricalcium phosphate formed by reversion. The two first mentioned are soluble in water, the neutral phosphates in ammonium citrate, but the last two states in neither. The equal value of the phosphates respectively soluble in water and in ammonium citrate has been proved experimentally. The author prepares ammonium citrate for this purpose by dissolving citric acid in ammonia to neutrality, bringing the solution to sp. gr. 1·09, and adding per litre 1·50 c.c. ammonia.

No. 3, March, 1880.

A local association for promoting the interests of the chemical arts has been established in Berlin.

The Position of the German Match Trade.—A protectionist paper.

Annual Report on Alcohols and Organic Acids.—An account of the sources and the consumption of these preparations in the chemical arts.

Retrospect of the Progress of the Coal-tar Industry for the last Ten Years.—Dr. R. Nietzki.—Rosaniline has lost much of its importance, and of its former derivatives only one aniline-blue (triphenyl-rosanilin) is now manufactured, Hofmann's violet aldehyd and iodine green having been respectively abandoned in favour of methyl-violet and methyl-green. An important step has been the conversion of rosaniline and methyl-violet into sulpho-acids, in consequence of which they gain in permanence, and can now be used along with acid. Malachite green, and especially benzoyl green, are proving formidable rivals even to methyl green. Victoria orange (binitro-cresol) and aurantia (hexan-nitro-diphenylamin) are rarely if at all employed, the azo colours having taken their place. The phthaleines (erythrosin, phloxin, cyanosin, &c.) are no less distinguished for their beauty than for their want of permanence.

Valuation of Reverted Phosphates (Conclusion).—M. Fleischer.—After a prolonged discussion it was resolved that the congress recognises the value of reverted phosphoric acid for certain soils, and does not object to its determination when desired by consumers or producers, but considers the evidence as to its valuation insufficient without further experiments.

Process for the Quantitative Determination o Stearin and Olein in Tallow.—M. Dallican.—A portion of the tallow is decomposed and the fatty acid obtained is examined for its congealing- and melting-points, which are then compared with those of mixtures of stearic and oleic acids in different proportions, as given in an accompanying table.

L'Orosi, Giornale di Chimica, Farmacia, e Scienze Affini.
No. 1, January, 1880.

Reciprocal Relations between the Atomic Weights of the Elements and their Properties.—Dr. Dario Gibertini.—This memoir, which is not concluded in the present issue, criticises the hypothesis of Prout and the speculations of L. Gmelin and Dumas on the progressions traceable in the atomic weights of elements belonging to certain groups.

The Mean Composition of the Saliferous Waters and of the Various Products of the Salt Works of St. Leopold, near Volterra, and the Theory of the Extraction of Salt there Practised.—A. Brasseur.—The rock-salt and the waters contain mere traces of iodides and bromides.

Santonin Contaminated with Strychnin.—Torquato Gigli.—Strychnin is stated to be a common impurity in commercial samples of santonin. For its detection the author recommends in preference to Flückiger's method, the following process:—1 grm. of the sample is placed in a small beaker, covered with a little distilled water, and acidulated with a few drops of sulphuric acid. On agitating with a glass rod the strychnin dissolves, while the santonin remains insoluble. The liquid is filtered, the

residue washed with a little water, and the washings added to the filtrate, which is then distributed in several test-glasses, and examined for strychnin by means of the usual reagents.

Reply to Prof. Ugo Schiff's Memoir on Certain Observations made in a former Paper of the Author's entitled "Researches on the Constitutional Formulæ of the Ferric Compounds."—Dr. D. Tommasi.—The author points out that he has not called in question the existence of the oxychlorides and basic nitrates of iron upon merely theoretical grounds, but on the faith of facts universally known and admitted.

Chemisches Central-blatt.
No. 12, March 24, 1880.

Nearly all the papers in this number relate to apparatus, and cannot be intelligibly reproduced without the accompanying engravings.

No. 13, March 31, 1880.

Action of Benzoyl-chloride and Benzo-trichloride upon Phenols.—O. Dœbner.—Benzo-trichloride acts upon phenols very differently from benzoyl-chloride. Without the presence of a metallic chloride it acts upon the nucleus of the phenols, 1 mol. combining with 2 mols. of the latter, whilst 3 mols. hydrochloric acid are eliminated. The products formed are all yellow or red, and are closely connected with the phthaleines and rosolic acid. The resorcin compound in solution displays a beautiful fluorescence, and yields with bromine a body much resembling eosin.—*Tageblatt des Natur. Vereins zu Baden-Baden*, 1879, p. 192.

Presence of Vanillin in Crude Sugars.—E. O. v. Lippmann.—The author has separated vanillin from certain kinds of raw beet-sugars.

No. 14, April 7, 1880.

Constitution of Liquids.—G. Cantoni.—The author maintains that at a given temperature every liquid contains in its intramolecular spaces vapours of its substance of the highest tension corresponding with such a temperature.

On Ultramarine.—H. Heumann.—A theoretical examination of the formation of ultramarine.—*Tageblatt des Natur. Ver. zu Baden-Baden*, 1879.

On Pilocarpine.—Alex. Pœhl.—An account of the optical and especially the spectroscopic behaviour of this base.—*Tageblatt des Naturf. Ver. zu Baden-Baden*, 1879.

Solubility of the Metals in Petroleum.—C. Engler.—The author, referring to the experiments of Dr. Stevenson Macadam, maintains that lead, zinc, tin, copper, magnesium, and sodium are only attacked by petroleum under the joint influence of air or oxygen, when acid compounds are formed, which the author is at present examining. Petroleum washed with caustic alkalies and distilled in carbonic acid has no solvent action on metals. The oxidising effect of oil of turpentine upon lead, does not, according to the author, depend upon the formation of ozone.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 13, March 25, 1880.

Megascope and Magic Lantern.—M. Lefevre.—The convertible instrument here described and figured is admittedly a toy.

Meteorological Optics.—M. Montigny.—After a prolonged observation of the scintillation of the stars, in which he has made use of a special instrument, the scintillometer, the author concludes that he has obtained a clue to the prevision of the weather. Very vivid scintillation indicates agitation or a fall of temperature in the upper regions of the air, and consequently the approach of bad weather. For the purpose of studying the supposed periodic variation in the colour of certain stars he has contrived a means of registering the colour of stellar light so as to obtain a series of comparable observations. It is also pointed out that the height of the barometer is influenced by the speed of the wind, and that altitudes taken in stormy weather may be erroneous to the extent of one-third.

Process of Sewage Purification.—M. Vivien de Saint Quentin.—A solution of sulphates and chlorides of iron and aluminium as obtained, *e.g.*, from the mother-liquors of the alum and copperas works is added to the sewage, and is then followed up by milk of lime. [Where is the novelty?]

No. 14, April 1, 1880.

Considerations on the Experimental Possibility of the Dissociation of Certain Non-Metallic Elements (Continuation).—Raoul Pictet.—The author concludes that in our laboratories we are limited both as regards the production of high temperatures and the quantity of heat available. In the analytical investigation of simple bodies we are stopped by the material impossibility of dissociations.

No. 15, April 8, 1880.

Antisepticity of Copper.—Dr. Burq.—The author considers it as proved that copper is a prophylactic against cholera and typhoid fever.

No. 16, April 15, 1880.

Nascent Hydrogen.—Dr. Donato Tommasi.—A continuation of the author's discussion with Dr. Phipson. He maintains that nascent hydrogen is calorified hydrogen, and that all the reductions produced with nascent hydrogen may be obtained as well with ordinary hydrogen at an elevated temperature.

Report on the Scientific Researches of the Members of the Learned Societies in the Departments Published in the Year 1879.—M. Emile Blanchard.—A most valuable collection of scientific investigations, many of which might otherwise escape notice.

Reimann's Färber Zeitung,
No. 8, 1880.

Copper in Silk.—Francezon has detected in raw silk a trace of copper, which he considers to be an original constituent of the fibre. It may probably have been derived from reeling the cocoons in copper vessels.

Nos. 9, 10, and 11, 1880.

These numbers contain nothing of general interest.

No. 12, 1880.

This number gives an account of the rise and progress of calico printing at Iwanowo Wosnessensk, in Russia, where there are at present 31 print-works in operation.

No. 13, 1880.

This number is almost entirely taken up with the correspondence between the Dyer's Association of Berlin and a representative of the yarn merchants.

NOTES AND QUERIES.

Stearate of Soda.—Would any of the readers of the Chemical News kindly oblige me with some information as to the manufacture of stearate of soda, and where it can be obtained in large or small quantities?—Ignoramus.

Analysis of Cinchona Bark.—Your correspondent, in his article on "Analysis of Cinchona Bark," in the Chemical News, vol. xl., p. 209, in reply to former query of mine, stated very clearly his method of determining the different alkaloids, with the exception of the cinchonidine. If the same correspondent would state his method of estimating the percentage of this alkaloid, and also give the rule for valuing the bark when the analysis and price of sulphate of quinine are known, it would much oblige.—L.

THE CHEMICAL NEWS.

Vol. XLI. No. 1074.

A NEW PATENT BILL.

Long and elaborate patent laws have been passed, and others discussed, but each one seems to have been on the principle that inventors as a body are criminals to be fined, and they are fined accordingly. They seek protection for the property of their creation, which they think is more their own than any land can be, but they are told that the Government only gives them a right to protect it themselves by legal means, and they are ruined in great numbers in the process. We know of a certainty that there are men who refuse to tell their ideas to the public because they will obtain nothing in return, except some reply such as that they are not the true inventors, and proof is expensive. There are even men who believe that no man ought to have any patent, because it is supposed to be better that the public should obtain all inventions free. It is said that ideas cannot be property. We say that they are the truest of all property; the only property which a man can take with him at last, and property that needs protection quite as much as a house.

A bill has been brought into Parliament by Mr. Anderson, Mr. Alexander Brown, Mr. Hinde Palmer, and Mr. Broadhurst, which has the advantage of being short. The bill puts the whole office of patents under three commissioners, who shall devote themselves to the work; they are to be appointed by the Lord Chancellor. The provisional protection is proposed to be extended to twelve months, the term of the patent to twenty-one years, and the intermediate payments to be made at the end of the 7th, 12th, and 17th years. Provision is also made for additions to patents on making payments of half the amount for the whole previous payments.

The progress of invention in America is stimulated by patents. Here patents are most unsatisfactory. We tax invention; we prevent men from working as long as they please, whilst we speak of free trade. We cannot do better than add here the letter of a distinguished and successful inventor:—"I Consider that the bill, if made law, would be a great boon. To give protection for seven years at the expense of £4 is a very great boon indeed to the working man. Things are occurring every day to mechanics which are entirely lost. As the law is at present it is totally out of the question for a working man to get a patent, but this Act would give him a patent for a price he could afford, and so stimulate his ingenuity to the great advantage of himself and the public; and giving twenty-one years instead of fourteen is a very great matter in many cases. There are many years spent in working and experimenting before any benefit accrues to the patentee. I think you will agree with me that these are great things. There are other things I think we have a right to, but let us get this if we can."

We think the advantages obvious, and it is strange that in a land of so-called liberty a man should find it harder to find protection for an idea which may enrich the world in time, rather than for some small piece of ground fit only to grow a few potatoes. It must be remembered that the idea is frequently of no value to the public unless it is protected for a few years, during which the growth takes place, and the slight germ becomes visible to all, or powerful for much good or for a little, according to circumstances.

We do not enlarge on this; we only mention the fact of the bill existing, as this does not seem to be well known, although we find that at a meeting in Glasgow of inventors, patentees, merchants, and manufacturers, a petition in its favour was drawn up, and it is to be presented to Parliament, we are informed, by Dr. Lyon Playfair.

NOTE ON THE BEARING ON THE ATOMIC WEIGHT OF ALUMINIUM OF THE FACT THAT THIS METAL OCCLUDES HYDROGEN.*

By J. W. MALLET, F.R.S.

In a recent communication to the Académie des Sciences† it has been pointed out by Dumas that metallic aluminium and magnesium, as well as silver, may contain sensible quantities of occluded gas, that obtained from aluminium being almost pure hydrogen.

In a paper on the atomic weight of aluminium, read before the Royal Society on the 22nd of April last, I gave, among other data, the results of several experiments on the quantity of hydrogen liberated by a known weight of aluminium from a strong solution of sodium hydrate. In examining beforehand the purity of the specially-prepared metal used, warned by Dumas's previous results as to gaseous occlusion by silver, of which due account was taken in the paper, I did not neglect to test in like manner the aluminium, but obtained an entirely negative result. As, however, I heated the metal in a Sprengel vacuum only to the highest temperature which a hard Bohemian glass tube would bear, while M. Dumas says that gas is only given off suddenly "*vers le rouge blanc*," I have since seeing his paper repeated the experiment in a porcelain tube, and at this higher temperature, obtained by means of an excellent gas-furnace, with a small remnant of the same material used in the atomic weight determinations.

4·783 grms. of the metal thus treated gave a small bubble of gas, which measured but 0·75 c.c. at 24° C. and 752 millims. pressure. Transferred to a miniature eudiometer it was exploded with oxygen, and seemed to be pure hydrogen. This is but little more than one-third the quantity of gas obtained by Dumas, but his experiments and my own with silver prove that the amount occluded varies with the conditions under which the metal has been fused, and two circumstances in the preparation of my aluminium probably tended to reduce the proportion of hydrogen taken up—namely, that, fearing possible contamination of the metal by its alloying itself with sodium at the moment of reduction from the bromide, I used a considerable excess of the latter, and that, not only were the ingots of sodium wiped free from naphtha with a cloth, but the outside surface was pared off with a knife, and only quite clear and solid pieces of the alkaline metal were used for the reduction.

The above volume of hydrogen only represents a weight of 0·000061 grm.; the corresponding weight from the largest amount of aluminium used in the atomic weight experiments of Series 3 A (in which the gaseous hydrogen evolved was *measured*), would be but 0·000010 grm., and the corresponding weight from the largest amount of aluminium used in Series 3 B (in which the hydrogen evolved was burned and weighed as water), would be 0·000067 grm.—both quantities too small to be determined by the balance used.

Even if it were possible to correct for this occluded hydrogen the weight of metallic aluminium taken, the greatest error in the volume of hydrogen obtained in Series 3 A would only represent 0·12 c.c., which would be barely measurable in the flask used, and would affect the atomic weight deduced for aluminium to an extent less than one-tenth of the probable error of the mean result. And in Series 3 B the greatest error in the weight of the water produced by combustion of the hydrogen would be 0·0006 grm., measurable by the balance, but affecting the result by less than three-fourths of the probable error of the mean.

Hence it appears that, although there is undoubtedly a constant error due to the cause pointed out by the great French chemist, its influence is in the present case in-

* A Paper read before the Royal Society, June 17, 1880.

† *Comptes Rendus*, 3 Mai, 1880, p. 1027.

appreciable by existing means of measurement, and no correction of the numbers obtained for the atomic weight in question can be applied which shall have any real meaning.

The other series (1 and 2) of experiments made to determine this atomic weight do not involve the question of gaseous occlusion, at any rate in the same form, as in them the metal itself was not used, but certain of its compounds only.

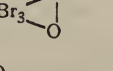
PRELIMINARY NOTE ON SOME ORCINOL DERIVATIVES.

By J. STENHOUSE, LL.D., F.R.S., and CHARLES E. GROVES.

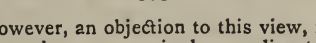
A few years ago some halogen derivatives of orcinol were described by one of us (Stenhouse, *Proc. Roy. Soc.*, xx., 72), in which five hydrogen atoms were replaced by the halogen, giving rise to penta-chlororcinol, $C_7H_3Cl_5O_2$, and penta-bromorcinol, $C_7H_3Br_5O_2$. It was thought at first that two, or perhaps three, of the halogen atoms occurred in the methyl group forming the side chain, but the preparation and examination of the corresponding resorcinol compounds at once showed that this could not be the case: apparently both of the hydrogen atoms in the OH groups of resorcinol, $C_6H_4(OH)_2$, were displaced, giving rise, when bromine was used, to the derivative—

$$C_6HBr_3(OBr)_2,$$

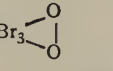
the orcinol compound being $C_6MeBr_3(OBr)_2$. This, however, was considered to be so improbable that the reaction was re-examined by Liebermann and Dittler (*Annalen*, clxix., 252), who fully admitted the correctness of the empirical formula above given: but as they found that penta-bromo-resorcinol readily parted with a molecule of bromine when it was heated—giving a compound of the formula $C_6HBr_3O_2$, which they called tribromo-resorquinone—and being unwilling to admit that the hydrogen in the OH groups had been directly displaced by the halogen, they regarded penta-bromo-resorcinol as an addition-compound of this tribromo-resorquinone, and assigned to it the formula—



or perhaps—



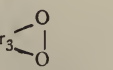
There is, however, an objection to this view, inasmuch as although penta-bromo-resorcinol, according to them, is an addition-product—



of tribromo-resorquinone, and it is known to be converted with the greatest readiness into tribromo-resorcinol,—

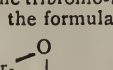
$$C_6HBr_3(OH)_2,$$

by the action of reducing agents; yet tribromo-resorquinone,—



itself is quite unacted on; moreover, the latter is not converted into penta-bromo-resorcinol by the action of bromine.

It seemed probable that if the tribromo-resorquinone had the composition expressed by the formula—



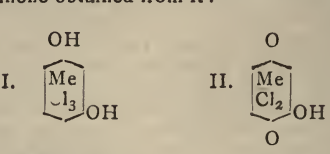
it would be produced from tribromo-resorcinol,—

$$C_6HBr_3(OH)_2,$$

by the action of oxidising agents. Trichlor-orcinol, as in many respects the most convenient compound, was accordingly treated in alkaline solution with potassium ferricyanide, but the result obtained was not in accordance with what would have taken place if the above supposition were correct. On mixing the solutions they acquire a deep purple colour, and if sufficiently concentrated, or if sodium chloride is added, long needles of a deep purple colour are deposited, which consist of the potassium or sodium derivative of a new compound having all the characters of a quinone. On adding hydrochloric acid to the aqueous solution of the purple needles, the quinone itself is precipitated in beautiful deep yellow scales having a brilliant lustre. These are sparingly soluble in water, very soluble in alcohol and in ether, but only moderately so in carbon bisulphide, which is the best medium from which to crystallise it. It melts at 156°, and when crystallised from hot benzene, in which it is readily soluble, separates on cooling in orange-red prisms: these give off benzene when exposed to the air, and effloresce to a brilliant yellow powder. The results of the analyses point to the formula $C_7H_4Cl_2O_3$. When this yellow compound is treated with reducing agents, such as sulphurous acid solution, it is converted into the corresponding hydroquinone or quinol, $C_7H_6Cl_2O_3$, which crystallises from benzene in colourless prisms. The quinhydrone produced by the union of the quinone with the quinol is a crystalline substance of a deep purple-brown colour. The quinone also yields a beautiful crystalline compound when acted on by bromine in presence of water, but we have not yet examined the nature of the reaction.

A resorcinol compound analogous with that above described has also been obtained from trichloro-resorcinol, but the result is not nearly so satisfactory, a large quantity of the trichloro-resorcinol being converted into by-products. It forms yellow crystals, which melt at about 65°. Corresponding bromine derivatives have also been obtained from tribrom-orcinol and from tribromo-resorcinol.

A consideration of the nature of the reaction which takes place in the formation of these compounds throws great light on the probable constitution of orcinol. The strongly-marked quinonic character of the derivative $C_7H_4Cl_2O_3$ points to the presence of the group $(O-O)''$ in the para position, as in benzo-quinone itself, whilst the OH group will occupy the meta position with respect to one of the oxygen atoms, I. representing trichlor-orcinol and II. the hydroxyquinone obtained from it:—



Trichlor-orcinol. Quinone.

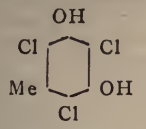
The reaction which takes place, therefore, may be represented by the equation—

$$C_6MeCl_3(OH)_2 + O_2 = C_6MeCl_2(OH)(O_2)'' + OH_2,$$

one of the chlorine atoms being displaced by an OH group, the hydrogen of that group and of another OH group occupying the para position with respect to it being simultaneously removed by oxidation.

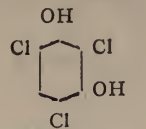
If we remember that when a halogen or the NO_2 group displaces one or more of the hydrogen atoms in phenol such hydrogen atom is in the ortho or para position with respect to the OH group, and not in the meta position, it would seem probable that none of the chlorine atoms in trichlor-orcinol occupies the meta position with respect to either of the OH groups, in which case it would have the formula III. This is confirmed by the fact that in resorcinol, although there are four hydrogen atoms directly united to carbon atoms, only three of these are displaced by the action of halogens, the one which is unaffected being in all probability in the meta position IV.

III.



Trichlor-orcinol.

IV.



Trichloro-resorcinol.

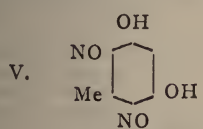
Additional evidence in favour of this view is that phenol forms a *mononitroso* derivative by direct substitution in which [OH : NO = 1 : 4], whilst orcinol yields a *dinitroso* derivative, which, from analogy, should have the NO groups in the same relative position with respect to the OH groups, as in V.

The formation of trinitro-resorcinol and trinitro-orcin, and the behaviour of betorcinol in forming only a *mono*-nitroso derivative, as recently described by us, all tend to show that in orcinol the CH_3 group occupies the meta-position with respect to the two OH groups, and therefore that it has the constitutional formula—

[OH : OH : Me = 1 : 3 : 5],

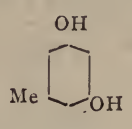
as represented in VI.

V.



Dinitroso-orcinol.

VI.



Orcinol.

Although Liebermann and Dittler (*loc. cit.*) found that penta-bromo-resorcinol and penta-bromorcinol lose a molecule of bromine when heated, yielding the compounds $C_6HBr_3O_2$ and $C_6MeBr_3O_2$ respectively, they were unable to prepare the corresponding chlorine compounds, as both of the penta-chlorinated derivatives volatilise unchanged. It seemed probable, however, that the trichloro-dibromo-compounds of the formulæ—

$C_6HCl_3(OBr)_2$ and $C_6MeCl_3(OBr)_2$

might behave differently. These compounds have accordingly been prepared by the action of bromine in presence of water on trichloro-resorcinol and trichlor-orcinol respectively. They are both colourless crystalline compounds, which give off bromine when heated, and yield crystalline products, in all probability the chlorinated derivatives corresponding with tribromo-resorquinone.

We are at present investigating the nature and properties of these interesting compounds.

THE

ABSORPTION OF SUGAR BY BONE-BLACK.

By HENRY A. MOTT, Jr., Ph.D., E.M.

IT is a pretty generally conceded fact amongst sugar chemists that bone-black absorbs sugar. The exact amount of absorption being variously stated, I determined to conduct a series of experiments to ascertain the fact for myself, as also to ascertain what influence the amount of bone-black usually employed in sugar tests had on the solution. Bone-black is used in two ways by chemists—it is either mixed directly with the solution to be decolourised and shaken up with it, or the solution is poured over a given amount of bone-black in a funnel.

It is evident, to determine the amount of sugar absorbed by bone-black, experiments should be conducted with perfectly pure sugar, as well as with impure sugars, as the latter contain other substances besides sugar, which affect polarised light, and which are apt to be absorbed, in part, by the bone-black, thus effecting the test of the sugar, and showing differences, which, in part, could be attributable to this fact.

It is also best in making comparative tests to dissolve sufficient of the sugar to be examined at once, so that the same solution may be used for all the tests, otherwise errors due to weighing, variance of sample, and diluting, might creep in, and alter the results. In all my recent experiments I have been careful to observe these points.

To find what influence bone-black would have on sugar solutions, if the solution was poured over a given quantity of bone-black in a funnel, I conducted a number of experiments (about a year ago), which were as follows :—

A solution of granulated sugar was made, which tested directly :—

Aqueous solution	99·9 per cent.
Solution to which had been added 3 c.c. of sulphate of soda and 7 c.c. of tri-plumbic acetate..	99·9 „

Solution filtered over 10 grms. of bone-black, tested as follows :—

First portion filtered	99·5 per cent.
Second „	99·7 „
Third „	99·9 „

An inferior sugar was next taken :

16·35 grms. were dissolved in water, to which were added 3 c.c. of concentrated solution of chloride of sodium and 7 c.c. tri-plumbic acetate, and the whole diluted to 100 c.c.

16·35 grms. more of the same sugar were dissolved in water, and sulphate of soda was added, instead of the chloride.

16·35 grms. more of the same sugar were dissolved in water, and 5 c.c. of tri-plumbic acetate were added, the whole being diluted to 100 c.c., and then filtered over 10 grms. of bone-black.

The first solution tested	85·3 per cent.
The second „	85·4 „

The third solution tested in three parts :

First part	84·9 per cent.
Second part	85·0 „
Third part	85·3 „

Many other tests were made, using the same bone-black with similar results. With different bone-black, perfectly free from water, much greater differences were observed in several experiments.

A sugar (decolourised with 3 c.c. Na_2SO_4 and 7 c.c. Pb sol.) tested, 89·1 per cent.

The same sugar, dissolved in water, and to which were added 5 c.c. Pb sol., and then passed over 10 grms. bone-black, tested in three portions, gave :

First portion	88·4 per cent.
Second „	88·7 „
Third „	89·1 „

Without any experiments—admitting the fact that bone-black absorbs sugars—I think it might reasonably be expected where sugar solutions are poured over a given quantity of bone-black in a funnel, that the first portion of the filtrate would be much weaker in saccharine strength than the last portion, for the bone-black would naturally saturate itself with the quantity of sugar it is capable of absorbing at once from the first portion, at a sacrifice of its strength. This is actually found to be the case, as the experiments I have just related clearly demonstrate.

Some experiments, conducted by the late Prof. Merrick, and reported in the CHEMICAL NEWS, arrived at the same results. It would be necessary to obtain an average if this method of decolourising were to be adopted—that either the whole solution be allowed to filter through the bone-black, and then be thoroughly mixed together, or that when one-half is filtered, it be poured on the bone-black and filtered again. This seems an utter waste of lime, when it is possible to mix the bone-black directly with the solution at the start. This method, therefore, must be abandoned as possessing no merit whatsoever.

The experiments which I have recently conducted have

been made with granulated, centrifugal, Muscovada, molasses and refined sugars, and in each case the bone-black was first mixed with the solution before filtering.

Before giving the results of these experiments, it may be interesting to present a few tests made by a number of chemists on the same solutions some few weeks ago, to determine the quantity of sugar bone-black is capable of absorbing. The experiments were conducted in Dr. Grund's laboratory. 130·240 grms. of a molasses sugar were dissolved in water, some tri-plumbic acetate was added, and the whole was diluted to 500 c.c., thoroughly shaken, and then filtered. A portion of the filtrate was tested. Then 50 c.c. of the filtrate were mixed and thoroughly shaken with 1 grm. of bone-black; 50 c.c. were mixed and thoroughly shaken with 3 grms. of bone-black; and to another 50 c.c. of the filtrate were added 5 grms. of bone-black, and the same was thoroughly shaken. Each was filtered separately and tested separately, by each chemist, as follows:—

	Grund.	Behr.	Messemy.	Mott.
The filtrate tested* ..	89·1	—	—	—
50 c.c.+1 grm. bone-black	89·0	88·9	89·1	89·1
50 c.c.+3 grms. ,,	88·6	88·8	88 9	88·7
50 c.c.+5 grms. ,,	88·4	88·3	88·7	88·4

From these experiments it will be seen, taking Dr. Grund's test for the plain filtrate as 89·1, and his test for the filtrate containing 10 grms. of bone-black in 100 c.c. of solution (5 grms. to 50 c.c.), as 88·4 per cent, the saccharine strength of the solution was lowered 0·7 per cent.

This reduction in the saccharine strength I found too great when experimenting with larger quantities of solution, and using the same and greater proportions of bone-black.

For example: 260·48 grms. of granulated sugar were dissolved in water, and diluted to 1000 c.c., and a portion of the filtrate was tested (1).

To 500 c.c. of the solution were added 100 grms. of perfectly dry bone-black, the whole was thoroughly shaken, then filtered and tested, first by my assistant Mr. Smylie (who very kindly assisted me in all of the following experiments), and then by myself (2).

To 50 c.c. of the filtrate were added 5 c.c. of water, the whole was thoroughly shaken and tested (3).

To 50 c.c. of the original filtrate, 5 c.c. of water and 5 grms. of bone-black were added, and thiswas filtered and tested (4).

To another 50 c.c. of the first filtrate were added 4 c.c. of tri-plumbic acetate, 1 c.c. of acetic acid, and 5 grms of bone black, the whole thoroughly shaken, filtered and tested (5).

The tests were as follows:—

	Smylie.	Mott.
Filtrate No. 1.	99·60 per cent	99 60 per cent.
,, No. 2.	98 90 ,,	98·90 ,,
,, No. 3.	90·50 ,, / 99·55 ,,	90·50 ,, / 99·55 ,,
,, No. 4.	90·10 ,, / 99·11 ,,	90·20 ,, / 99·22 ,,
,, No. 5.	90·30 ,, / 99·33 ,,	90·20 ,, / 99·22 ,,

From the first two tests it will be seen that the saccharine strength of the solution was reduced 0·70 per cent, by 20 grms. of bone-black to 100 c.c. of solution; this would prove that 10 grms. reduce it only 0·35 per cent instead of 0·70 per cent, as in the experiments quoted above. From comparison of filtrates 3, 4, and 5 in this experiment, it is also shown that 10 grms. of bone-black only reduce the strength of the solution 0·30 per cent.

Another experiment led to similar results:—

260·48 grms. of granulated sugar were dissolved in water, and diluted to 1000 c.c.

* Owing to its being too dark, the tests were not considered reliable.

	Smylie. Per cent.	Mott. Per cent.
500 c.c of filtrate+50 grms. of bone-black	99·30	99·30
Filtrate alone	99·60	99·60
50 c.c. of filtrate+5 c.c. water ..	90·40 / 99·44	90·40 / 99·44
50 c.c.+5 c.c. water+5 grms. bone-black	90·10 / 99·11	90·10 / 99·11
50 c.c. of filtrate+4 c.c. tri-plumbic acetate+1 c.c. acetic acid+5 grms. bone-black	90·10 / 99·11	90·10 / 99·11

From these experiments, the reduction in saccharine strength was 0·3 per cent, by 10 grms. of bone-black.

Experiments with Centrifugal Sugar.

260·48 grms. were dissolved in water and diluted to 1000 c.c., and filtered.

	Smylie. Per cent.	Mott. Per cent.
50 c.c. of filtrate+2 c.c. of conc. solution of salt+3 c.c. of tri-plumbic acetate	87·20 / 95·92	87·20 / 95·92

500 c.c. of filtrate+100 grms. of bone-black were filtered.

	Smylie. Per cent.	Mott. Per cent.
50 c.c. of this filtrate+5 c.c. of water	87·20 / 95·70	87·20 / 95·70
50 c.c. of same filtrate+1 c.c. of acetic acid+4 c.c. of lead solution ..	96·90 / 95·59	87·00 / 95·70

From these experiments 100 grms. of bone-black to 500 c.c. of solution, or 20 grms. to 100 c.c. solution, only reduced the strength 0·20 per cent; therefore, 10 grms. would only reduce it 0·10 per cent.

Experiments with Refined Sugars.

260·48 grms. of a refined sugar marked "D" were dissolved in water, and diluted to 1000 c.c.

	Smylie. Per cent.	Mott. Per cent
50 c.c. of filtrate+2 c.c. of salt+3 c.c. of lead solution	75·00 / 82·50	75·00 / 82 50
50 c.c. of filtrate+½ c c. acetic acid +4½ c.c. of lead solution+5 grms. bone-black	74·40 / 81·84	74·40 / 81·84

From this experiment, 10 grms. of bone-black reduce the saccharine strength of the solution 0·66.

Experiments with Granulated Sugar, using Prepared Ivory-Black instead of Ordinary Bone-Black.

260·48 grms. of the sugar were dissolved in water, and diluted to 1000 c.c.

	Smylie. Per cent.	Mott. Per cent.
50 c.c. +5 c.c. of water	90·60 / 99·66	90·60 / 99·66
50 c.c.+2 c.c. of salt+3 c.c. Pb sol.	90·55 / 99 60	90·60 / 99·66
50 c.c.+4 c.c. Pb sol.+1 c.c. of acetic acid	90·70 / 99·77	90·60 / 99·66
50 c.c.+5 c.c. water+5 grms. bone-black..	90·00 / 99·00	90·00 / 99·00

From this experiment, 10 grms. of ivory-black absorb 0·66 per cent of sugar.

Without giving any more of the experiments I have conducted, I will briefly state the conclusions I have arrived at:

1st. That 10 grms. of bone-black will absorb from a solution of perfectly pure sugar (26·048 in 100 c.c.), sufficient sugar to weaken the saccharine strength of the solution 0·30 per cent to 0·35 per cent.

2nd. That 10 grms. of bone-black will absorb sufficient sugar, and, also, other substances which effect polarised

light, from a solution (26·048 in 100 c.c.) of an impure or raw sugar, so that the saccharine strength of the solution will show a loss of from 0·10 per cent to 0·66 per cent by the direct test, but only 0·30 to 0·35 per cent by the inverted test.

3rd. That some perfectly dried bone-blacks will absorb more sugar than others.

4th. That the greatest amount of absorption by 10 grms. of any kind of prepared bone-black on a solution of pure sugar (26·048 in 100 c.c.), is only sufficient to reduce the saccharine strength of the solution 0·70 per cent.

5th. Since 2 grms. of bone-black are quite sufficient to decolourise a filtered sugar solution which has been partly clarified and decolourised by means of tri-plumbic acetate, it can be used with safety, as the amount of sugar it will absorb would hardly effect the saccharine strength of the solution appreciably.

6th. Supposing 10 grms. of bone-black to reduce the saccharine strength of a solution (26·048 in 100 c.c. water) of pure sugar testing 100 per cent, exactly 0·35 per cent, then we can deduce the fact, that 1 ton of bone-black will absorb 18·2 lbs. of sugar, or, bone-black is capable of absorbing 0·0091168 per cent of sugar.—*Journal of the American Chemical Society.*

DISTILLATION OF GAS-TAR.

Tar Distillers *v.* Gas Companies.

Amongst the many industries that have been pursued as the arts and manufactures have progressed few stand out so prominently, conspicuous in the strides made, and in the results that have accrued, as those presented to our contemplation in the discoveries achieved in dealing with a once refuse substance occurring in vast quantity, and which has been rescued and reclaimed from the opprobrium of "waste,"—a material which at one time, and not distantly removed from the present, was looked upon and regarded as utterly useless and worthless: we refer to the product widely known as gas-tar.

Formerly, at our gas works and in the distillation of coal everything obtained was looked upon as waste except the illuminating gas, carburetted hydrogen. True it is that the resultant tar was collected and even used, much of it serving as fuel under the retorts employed in producing the gas: but withal it was regarded as a most unpleasant companion, to touch which was to be defiled. From the period referred to to our own day what a change has passed over the interval and the spirit of men's minds as directed and governed by the impulse of progress. It has been said, from the "pine torch to the paraffin candle how wide the interval! between them how vast the contrast!" May we not extend the thought a little further, and, embracing our modern gas illumination, view it as a still wider and grander interval. Continuing our flight, and without in any way encroaching on the realms of romance, may we not further regard this reclaiming of a waste substance, and its history as exemplified in the endless variety of valuable substances—inclusive of the magnificent and beautiful colouring matters derived from it—as one of the most wonderful industries of modern times; wonderful alike to the scientific investigator and discoverer and the eager speculator, who has not been tardy in availing himself of its solid and substantial benefits, and which in its commercial aspect has, and will still continue to, command millions of capital. That this statement is in nowise exaggerated, we need only point our readers to public statistics of products derived from coal-tar during the past twenty years—historical on the one hand, widely popular and well known on the other.

We have been led to these thoughts from notice of a remarkable movement now taking place amongst our public gas companies, and which may be looked upon as the starting-point of an altogether new state of things in the history of tar distillation; as one bidding fair to revolutionise the old and existing system, and as calculated to introduce reforms for which there can be no doubt there is a broad and wide latitude. We refer to the growing disposition on the part of these companies to erect plant and utilise their once refuse gas-tars.

As everyone knows, for a number of years past this industry has remained in the hands of the tar distiller; and it is not too much to say that in the majority of cases few branches have suffered more in remaining so long and lamentably in the background for want of scientific aid and direction.

If we have to take our coal to the gas-house—and there subject it to destructive distillation as the process is called, and in order to obtain the gas with which we illuminate our towns and dwellings—we have, or rather have had, to take our gas-tar to the tar distiller so-called, and there leave it in his hands in order to treat and obtain from it a moiety only of the valuable products existing in it.

That we are not, in thus expressing ourselves, overtopping the limit of fact we are tolerably well assured. Nay more; we have a lurking impression that the tar distiller has hitherto cared little either for the chemistry of his subject or what may have come out of it: in the majority of instances he has been quite content to jog on and distil tar, indifferent alike to the opportunities and advantages presented to him in material at command and the wide field for research and discovery accruing from the pursuit of his avocation. Whilst manufacturers in other directions, keenly alive to advantages resulting from the most trifling improvements in their processes, have been ready to adopt and develop them, the tar distiller notably has stood aloof, notwithstanding the remarkable discoveries of science, which have pointed to the products of his labour as a practically limitless and inexhaustible field of investigation—a mine of wealth presented perhaps by no other department of applied chemistry. As regards the pecuniary results attached to the pursuit of this special industry, and in a commercial sense, we have always been led to believe them as visionary if not *nil*. Notwithstanding, however, these assertions there has long existed a shrewd suspicion that behind the black and offensive material there has after all been a "silver lining," and a mine that has brought much grist to the mill of the distiller. Possibly this surmisé has not existed without tangible foundation, regard being had to the manner in which some of our tar distillers have extended their operations in tar products, and in a direction which has undoubtedly invited attention to their doings and the magnitude of the issue. That our gas companies should at last have woke up from their lethargy, and to the fact that in disposing of their tar they have relinquished a vast and remunerative source of revenue is not at all surprising, and that some of them should even have reached the not altogether illogical reasoning that distillation and utilisation of their own tar is perhaps equally within their legitimate province, as the conversion of crude tar products into actual colouring matter by the tar distiller himself, due regard being had to the somewhat wide range running between tar distilling on the one hand and colour making on the other. That such an awakening should have occurred is, we reiterate, by no means astonishing, and the almost general desire evinced on the part of others to contest the point and follow in the wake of one of our largest and most influential public companies, who have set the example on a most magnificent scale, exhibits, we think, a fact that is not without significance and import as regards the future.

In reviewing the claims of the contending parties we hold that the movement now taking place and influencing our gas manufacture is a step in the right direction, and as calculated to introduce progress and reform in a process hitherto admittedly crude. We hold that the distillation of tar and its conversion into such products as ammonia, benzol, naphthas, carbolic acid, creosote, and anthracen up to pitch, as strictly within his province, and one to which he cannot long remain indifferent. Furthermore,

we hold that in absorbing the larger share of the industry, and which we believe he ultimately will do, he lifts it from an antiquated and empirical position, and places it on a footing where it will receive the many advantages derivable from the infusion of new blood, and the supervision and direction springing from the more advanced knowledge and requirements of the times in which we live. We think it is not too much to hazard this assertion, inasmuch as already do we see fruit of a venture that at the period of its contemplation was met with considerable rebuff and evil prognostication. It was urged, on the one hand, that "no gas company would either distil or succeed in distilling tar." It was said, on the other, that they "lacked experience and knowledge impossible to obtain: more, that even if actually "launched and in operation they would fail in showing financial success." Yet, in direct opposition to these statements, what do we really see? Within the brief space of a few short months has sprung up in our midst one of the finest and most perfect plants for tar distilling in the kingdom, and on the grounds and within the walls of an English Gas Company, second to none in dimension, efficiency, utility, and advantages derivable from the adoption of modern improvement, which, by-the-bye, as regards some of them (curiously enough) are only now finding their way into other establishments whose origin have not been altogether of yesterday's date.

Here we have the nucleus of a concern that may, as time progresses, possibly rival that of our continental neighbours, the French, although whether we shall at any time award a like amount of scientific interest and enquiry to the pursuit of a commercial object is altogether another matter. Whether we shall ever conduct in our technical laboratories a class of work such as is carried out in those of the Paris Gas Company under the able directorship of its accomplished chemist and professor, M. Audouin, or appoint at their head men of similar talent and capacity, is also a matter of considerable surmise.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 17, 1880.

Prof. H. E. ROSCOE, President, in the Chair.

THE following certificate was read for the first time:—A. C. Hawkes.

During the evening a ballot was taken, and the following gentlemen declared duly elected Fellows of the Society:—P. S. Brown, H. Brown, K. dal Dey Rai Bahadour, G. H. Hughes, H. A. Lawrance, F. E. Matthews, E. Moritz, R. S. Marsden, E. A. Reilly, Tarapwsanna Roy, C. Rawson, B. Symons, T. Taylor, H. K. Tompkins, R. G. Watts, A. Wingham.

The following papers were read:—

"*On Pentathionic Acid*," by T. TAKAMATSU and WATSON SMITH. The authors, at the suggestion of Dr. Roscoe, have examined the proofs for and against the existence of this substance advanced by Wackenroder, Spring, Stingl, and Morawski, Kessler, &c. The acid was originally prepared by Wackenroder by passing hydrogen sulphide into a saturated solution of sulphurous acid. Spring obtained what he thought was the potassium salt of the acid in an alcohol-ether solution, and proved it to be merely a tetrathionate. Stingl and Morawski proved, by qualitative and quantitative results, that an acid containing more sulphur than tetrathionic acid exists in Wackenroder's solution. Spring also asserts that the alleged solution of pentathionic acid contains a mixture of tetrathionic and hyposulphurous acids. The authors have confirmed the results obtained by Kessler in the investigation of the reaction of Wackenroder's solution with mercuric cyanide—

$$H_2S_5O_6 + Hg(CN)_2 + 2H_2O = 2H_2SO_4 + HgS + 2HCN + 2S.$$

The ratios between the S in the sulphuric acid to that in the HgS to that existing in the free state were 2·01 : 1 : 2·08, whereas tetrathionic acid would give 2 : 1 : 1. They have also investigated the statement of Spring that the Wackenroder solution is not decomposed by alkaline hydrates, but yields a solution containing tetrathionate without separation of sulphur. The authors prove that a decomposition really occurs and that sulphur is separated, but its separation is masked, because as fast as it is precipitated it is re-dissolved by the alcohol-ether solution. They also prove that no hyposulphurous acid is present in the Wackenroder solution. They finally synthesised both tetrathionic and pentathionic acids by acting upon lead thiosulphate in the first instance with a moderately strong solution of iodine in hydriodic acid, when tetrathionic acid was produced, and secondly by acting on lead thiosulphate by as strong a solution of iodine in hydriodic acid as could be obtained when pentathionic acid was formed,—

$$3(PbS_2O_3) + 2HI + 2I_2 = H_2S_5O_6 + 3PbI_2 + SO_3.$$

Analyses of the products are given. The authors conclude that pentathionic acid exists, and recommend the reaction just given as a convenient and expeditious method of preparing it. They hope to be able to prepare some of the pentathionates which, under ordinary conditions, are less stable than the acid. In conclusion, they contrast the reactions of the thionic acids; pentathionic acid being distinguished by giving an immediate precipitate of sulphur with caustic potash, re-dissolving gradually on standing, and an almost immediate brown colouration, becoming black on warming with ammoniacal silver nitrate.

"*Preliminary Note on some Orcinol Derivatives*," by J. STENHOUSE and C. E. GROVES. Printed in full in another column.

"*On the Determination of Carbon in Soils*," by R. WARINGTON and W. A. PEAKE. The authors have examined the various methods which have been proposed:—Oxidation by chromic acid, suggested by Wolff (this gives but 79 per cent of the carbon present); oxidation by permanganate. 10 grms. of the soil, with 5 grms. KHO in 25 c.c. of water and solid permanganate, are digested in a salt-bath for an hour. The mass is then treated with H_2SO_4, and the CO_2 evolved absorbed. This method gives 92 per cent of the total carbon. The best method is that of combustion in oxygen with oxide of copper, after treatment with sulphurous acid.

"*Note on Camphydrene*," by H. E. ARMSTRONG. The author sharply criticised a recent paper by Dr. Letts in the *Berlin Berichte*, in which Dr. Letts repeats an assertion made some months ago at this Society that the chief product of the action of sodium on the solid hydrochloride from turpentine oil is apparently homogeneous, as it has a constant boiling-point, and soon attains a constant melting-point on re-crystallisation from alcohol, and that its formula is $C_{10}H_{17}$, the mean only of ten analyses being given, which corresponds closely with $C_{10}H_{17}$. Dr. Armstrong asked whether these ten analyses were the same as those brought before this Society, and which were widely discordant. Dr. Armstrong has also repeated the experiments of Montgolfier, and completely confirms his conclusions that a *mixture* of camphene, $C_{10}H_{16}$, and of camphydrene, $C_{10}H_{18}$, is produced: from this mixture the latter substance can be isolated by agitation with 2 : 1 sulphuric acid and steam distillation. Thus a larger yield of the hydrocarbon can be obtained than by Montgolfier's process.

"*On the Action of Nitric Acid upon Dipara-tolyl-guanidine*," by A. G. PERKIN. This substance dissolves in strong nitric acid (sp. gr. 1·5) with rise of temperature. From the product, ammonia, after dilution and filtration, precipitates a new base having the formula $C_{15}H_{15}N_5O_4$, dinitro-dipara-tolyl-guanidine, melting at 205°, soluble in

cold alcohol, insoluble in water: it crystallises in red prisms. Treatment with tin and hydrochloric acid yields a new base, which is under investigation. By mixing an alcoholic solution of the nitrate of ditolyl-guanidin with its own volume of nitric acid (sp. gr. 1·4), and heating until chemical action ensued, another substance, crystallising in primrose needles, was obtained, which proved to be dinitro-dipara-tolyl-urea, melting with decomposition at about 233°. On boiling this substance with alcohol acidulated with hydrochloric acid and tin diamido-dipara-tolyl-urea was obtained in minute crystals. Ortho-ditolyl-guanidine, when treated with fuming nitric acid, also forms a nitro-base, which the author is at present investigating.

"*On some Higher Oxides of Manganese and their Hydrates*," by V. H. VELEY. In order to avoid any possible contamination with alkalies the author proceeded as follows:—A solution of manganese chloride was precipitated with ammonium sulphide. After washing, this was dissolved in acetic acid and diluted, and a current of chlorine passed for a limited time at 52° C. Black glistening scales were precipitated, which were air-dried. This substance is a hydrate, $MnO,5MnO_2$. After heating to 200° to 250° it was found that the oxide did not lose weight, even when heated for several hours, and that the loss of the weight of the oxide did not agree with the gain in weight of the drying-tube. The oxide dried for many hours at this temperature retained a small but constant quantity of water. This constant oxide was found to be a monohydrate of a high oxide, $MnO,11MnO_2$. The loss of water during the heating of the substance to 200° in dry air is simultaneous, but not necessarily dependent upon the absorption of oxygen. Experiments were made to determine the various hydrates of the oxide, and the lowest temperature at which oxidation begins in air and in oxygen. The oxide was heated in a slow current of air at intervals of 10° from 60° to 210°, and the loss and the water determined, each experiment lasting two hours. In air the principal points were 60° to 100° for $MnO,5MnO_2,2H_2O$; at 120° to 130°, $2(Mn_6O_{11}),3H_2O$; at 200°, $Mn_{12}O_{33},H_2O$. On repeating the experiment with oxygen instead of air further oxidation took place, and an oxide, $MnO,23MnO_2$, was obtained. In no case was the dioxide formed.

"*On a New Method of Preparing Dinitro-ethylic Acid*," by E. FRANKLAND and C. C. GRAHAM. This substance, N_2EtOHO, was first prepared by the action of zinc-ethyl upon nitric oxide. The process was, however, difficult and inconvenient (*Phil. Trans.*, 147, 59). They have adopted the following plan, which works well:—100 grms. of pure zinc-ethyl are introduced into a tubulated distilling flask, and enough sodium added to convert all the zinc-ethyl into the compound $ZnNaEt_3$, taking care to keep the temperature down. When all action has ceased 100 c.c. of benzene are added, and the nitric oxide passed over the solution, the flask being shaken from time to time. When the absorption has ceased some commercial ether is added to the cooled contents. The zinc-ethyl is thus gradually decomposed, and finally the decomposition is completed by adding first some alcohol and then water. The zinc is precipitated by carbonic anhydride, and the filtrate evaporated to dryness. On treating the residue with absolute alcohol the sodic dinitro-ethylate alone dissolves out. It is purified by conversion into the copper salt: in some cases a yield of 50 per cent of pure copper salt was obtained. A further study of the reactions of this acid is promised.

"*On the Action of Organo-zinc Compounds upon Nitriles and their Analogues* (*III. Action of Zinc-ethyl on Phenyl-acetonitrile*)," by E. FRANKLAND and H. K. TOMPKINS. The phenyl-acetonitrile employed was prepared by digesting benzylic chloride with a solution of crude potassic cyanide in dilute alcohol. In one experiment, while preparing this substance on the large scale 2000 grms. of the chloride being used, a substance was observed to distil over above 300°. The distillation was stopped: the residue solidified on cooling, and was found to contain tribenzylamine. The authors were unable to obtain phenyl-acetonitrile perfectly pure, and they therefore employed the portion of the distillate boiling at 200° to 230°. On treating it with zinc-ethyl a reaction immediately began, and had to be checked by cooling. Towards the end the temperature had to be raised to 130°. The product is decomposed by alcohol, and finally extracted with that liquid. The crystals thus obtained contained two substances, the least soluble fusing at 170° to 171°, crystallising in silky acicular tufts; the second fused at 150°, and crystallised in rhombohedra. The first substance has the same empirical formula as phenyl-aceto-nitrile, but differs from it in all its physical properties. From analogy its formula should probably be tripled: the authors propose to call it Cyanbenzine. It is sparingly soluble in hot alcohol; glacial acetic acid, benzene, and carbon disulphide dissolve it readily. Analyses of the second substance indicated the formula $C_{32}H_{27}N_3O$. The authors have named it Benzacin. It is a neutral body. The mother-liquor from these two bodies contained a high boiling-point oil, which the authors have not yet succeeded in satisfactorily isolating and purifying.

"*On the Action of Benzoyl Chloride on Morphine*," by C. R. A. WRIGHT and E. H. RENNIE. The authors prove, by various analyses and other quantitative measurements, that by heating benzoyl chloride and morphine in sealed tubes to 100° to 110° for several hours, the end result is invariably dibenzoyl morphine $(C_{17}H_{17}NO)(OC_7H_5O)_2$, morphine being for simplicity's sake regarded as $C_{17}H_{19}NO_3$, and that the product thus formed is identical with that formed by the action of benzoic anhydride on morphine. The conclusions recently arrived at by Polstorff (CHEMICAL NEWS, vol. xli., p. 220) that a tribenzoylated base is formed are shown to be utterly without foundation, Polstorff's own analytical figures rather indicating that the substance examined by him was the dibenzoylated base, whilst no determination at all of the molecular weight or of the quantity of benzoic acid regenerated by saponification was made as a check. Morphine contains two-thirds of its oxygen in the form of hydroxyl, and one-third functioning in some other way, as has been shown by C. R. A. Wright in conjunction with G. H. Beckett.

"*On an Examination of Terpenes for Cymene by means of the Ultra-violet Spectrum*," by W. N. HARTLEY. In a previous paper (*Proc. Roy. Soc.*) the author, with Prof. Huntington, has shown that cymene gives a well-marked absorption spectrum, which is not entirely obliterated by dilution with 5000 volumes of alcohol, if a layer of 15 m.m. in thickness be used. The author has in this way tested samples of orange oil, French turpentine, and Russian turpentine, received from Dr. Armstrong, for cymene. The first two substances contained no cymene; the Russian turpentine contained less than 4 per cent. The author concludes that the cymene found in these oils by Dr. Armstrong was formed by the chemical treatment to which they were subjected. The author examined the so-called terebene, which is also free from cymene.

"*Notes on the Purple of the Ancients*," by E. SCHUNCK. The author has examined a sample of cotton recently dyed with the juice of a species of shell-fish, *Purpura patula*, obtained through Herr von Stralendorff, from the west coast of Nicaragua, where this method of dyeing is still practised by the natives. The purple was dull and not so brilliant as was expected; it was dissolved out of the fabric by boiling aniline, and was found to have all the properties of the Punicin previously obtained by the author from the *Purpura lapillus* of the British coasts. It is characterised by its extreme stability, especially with regard to powerful oxidising agents. It dissolves in concentrated sulphuric acid, yielding a dull purple solution, having an absorption band between D and E. On heating this solution and allowing it to stand the colour changes to a bright green, and the band disappears. This green solution gives with water a purple precipitate.

The Society then adjourned over the summer recess.

PHYSICAL SOCIETY.

Ordinary Meeting, June 12, 1880.

Dr. Huggins, F.R.S., in the Chair.

New Members:—Mr. H. B. Luff, Mr. Adam Hilger, Mr. C. V. Boys.

Dr. Shettle, of Reading, read a paper "*On the Influence of Solar Radiation on the Earth's Rotation.*" The fact established by Dr. Shettle, that the magnetic energy of a bar-magnet acts along spiral lines, has led him to surmise that the energy emanating from the sun and impinging on the earth on the zone of the ecliptic traverses the earth in a spiral path, and finally emerges at the magnetic poles. The spiral of energy is "right-handed" at one pole and "left-handed" at the other, like the magnetic force in a magnet, and the electric discharge in Crookes's vacuum tubes. Like to precession and nutation these spiral paths are constantly changing and producing magnetic variations. He therefore infers that the magnetic poles will complete a cycle corresponding to the period of precession. Dr. Shettle thinks that bodies exhibit magnetic properties in proportion as they change the direction of the energy traversing them, and throw it into the spiral form. Terrestrial magnetism would be due to the solar radiance. On this hypothesis gravity also would be produced; so, likewise, would the earth's rotation (by a kind of "magnetic whirl"), electricity, tornadoes, cyclones, water-spouts, and whirlwinds. Moreover, this "spiral energy" would seem to operate throughout the whole universe.

Prof. Wiedemann, of Leipsic, made a communication "*On the Phenomenon of Interference in Rays of Long Path,*" and showed how the phase of vibration of the atom or molecule emitting the rays influenced the phenomenon. Molecular collisions could operate in preventing interference. From a study of this question he was able to deduce a method of determining the pressure on the surface of the sun and stars. He mentioned that he had found that the temperature of a glowing gas in Geissler's tubes may be under 100° C., and therefore the light of the aurora or of comets might be accompanied by a low temperature. He had determined that the quantity of heat produced in a gas by the electric discharge was always the same with the same amount of electricity, whether discharged at once or not, and that it increases nearly in proportion to the pressure of the gas. He had also determined that the heat which must be developed by a discharge in hydrogen in order to change the band spectrum of H into the line spectrum is about 100,000 calories for 1 gramme of hydrogen, and hence this might represent the amount of heat necessary to transform the hydrogen molecule into its atoms.

Dr. Schuster suggested that Prof. Wiedemann should make a similar experiment with another gas, say nitrogen, as there was a disagreement about the H spectra, and Professor Wiedemann stated that he so intended.

Mr. Ridout exhibited a device for amplifying small motions. A small barrel is slung by two threads between the prongs of a metal fork in such a manner that if the fork is bodily carried to and fro the barrel will rotate round its axis. This is simply effected by making each thread, in its passage from one prong to the other, take a few turns round the barrel. To the barrel an index is attached, and the fork is then fixed on the body whose minute motion is to be indicated. The translation of the body shifts the fork and rotates the barrel, which in turn deflects the index round the face of a dial, and the magnifying power is expressed by the ratio of the diameter of the barrel to the length of the index. With this apparatus Mr. Ridout exhibited the lenthening of an iron core when magnetised by the passage of the current of two Grove's cells through an insulated wire coiled round it. By rivetting a slip of brass to the iron the unequal expansion of brass and iron under heat were also shown, the heat being generated by keeping the current flowing in the coil.

Mr. D. Winstanley exhibited his new radiograph for recording graphically the intensity of solar radiation throughout the day. It consists of a differential thermometer, with one black bulb and a circular stem. The lower part of the stem is filled with mercury, the upper branches with sulphuric acid and water. The tube is mounted on a brass wheel, so that when the black bulb is exposed to the sun's rays the differential motion of the mercury causes the wheel to turn. The wheel carries a light index or marker, which is free to traverse a vertical cylinder covered with paper coated with lamp-black, and leaves a white track where its point has scratched off the soot. The radiogram thus produced can be fixed and preserved.

Dr. Guthrie pointed out the curious "thermal twilight" these radiograms had betrayed to Mr. Winstanley. They show that before sunrise the temperature increases owing to solar radiation. Moreover, half an hour after sunset the index falls, and remains till within a few minutes of midnight, when it mysteriously rises and sinks again, although the sun is then directly over the opposite hemisphere.

Mr. Baillie then gave the results of a study he had made into the theory of the phoneidoscope. He finds that waves simultaneously start from each side of the soap film when the note is sounded, and, meeting in the middle, generate ventral points and notes. The equations of several cases were given by him, and he suggested that photography should be employed to fix the appearance of the figures in order that they might be investigated theoretically.

THE METEOROLOGICAL SOCIETY.

The last Ordinary Meeting of this Society for the present session was held on Wednesday, the 16th inst., at the Institution of Civil Engineers, Mr. G. J. Symons, F.R.S., President, in the Chair. T. W. Barry, M.D., A. W. Martin, and C. E Peek were elected Fellows; and Senor A. Aguilar and Dr. H. H. Hildebrandsson were elected Honorary Members of the Society. The following papers were read:—

"*Ozone in Nature, its Relations, Sources, and Influences, &c.,*" from fifteen years' observations ashore and afloat under all conditions of climate, by J. Mulvany, M.D., R.N. The meteorological elements with which ozone is most intimately associated are such as occasion high vapour tension and a high degree of saturation: therefore it is promoted by wind passing over a large aqueous expanse and by heat producing rapid evaporation. Hence heat, if humid, is no bar to atmospheric ozonisation, but no definite relation exists in the atmosphere between heat *per se* and ozone; its relation to humidity is more definite and direct, but subject to many exceptions. In consequence of this relation it most abounds where its chemical qualities render it most useful. It appears to be formed in the upper strata and to be carried downwards by raindrops, whose office is vehicular. The spherules of water which constitute clouds and have their origin in radiation and condensation, have a similar office. Ozone does not appear to diffuse readily downwards, so that when the lower strata are robbed of ozone by jungle, &c., a considerable difference in the ozonic condition close to and at 170 feet above the surface may exist. The author is of opinion that no disease can be clearly traced to ozone as met with in the atmosphere.

"*The Average Weight of the Barometer in London,*" by Henry Storks Eaton, M.A., F.M.S.

"*Note on a Waterspout Observed at Morant Cays, Jamaica, March* 23, 1880," by Lieut. Alfred Carpenter, R.N., F.M.S.

"*Account of a Balloon Ascent from Lewes in a Whirlwind, on March* 23, 1880," by Capt. James Templer and H. Elsdale.

"*Results of Meteorological Observations made at Stanley, Falkland Islands*, 1875-77," by William Marriott, F.M.S.

"*A New Thermograph*," by William David Bowkett.

"*The Winter Climate of Davos*," by C. T. Williams, M.D., F.M.S. Among the high altitude sanitaria of Europe, Davos at present enjoys the greatest reputation, partly on account of its easy accessibility, and partly on account of certain peculiarities of position and shelter. The Valley of Davos lies in the Canton of the Grisons, between the valleys of the Lower Rhine and the Upper Engadine. The valley runs from N.N.W. to S.S.E. for about 10 miles in length, with an average breadth of about a third of a mile, being for the most part of this extent a plain, gently sloping towards the north, and varying in elevation from 5400 to 4500 feet. Davos Platz is 5105 feet above the sea level. The author discusses the observations made during the four winters of 1876-7 to 1879-80. The peculiar effects of Davos winter climate seem to depend on (1) The rarefaction of the atmosphere; (2) Its dryness; (3) The absence of strong currents, owing partly to shelter, and partly to the uniform layer of snow spread around; and (4) The large percentage of the *direct* solar rays reaching the locality owing to rarefaction of the air, aad also the considerable amount of heat reflected from the extensive snow plain in front of the villages of Davos Platz.

NOTICES OF BOOKS.

Nature's Hygiene; a Series of Essays on Popular Scientific Subjects, with Special Reference to the Chemistry of the Eucalyptus and the Pine. By C. T. Kingzett, F.C.S. London: Baillière, Tindall, and Cox.

In examining this interesting work we will first turn our attention to the fourth chapter, in which the author treats of infectants and contagious diseases. After enumerating some of the most signal epidemics recorded in history—among which he places the miasmatic fever of Cyprus in 1878-79—he quotes from Dr. Drysdale's work on the Germ Theory ("The Germ Theories of Infectious Diseases." By J. Drysdale, M.D. London: Baillière, Tindall, and Cox) the statement that in view of "the almost total impotence of medicine for direct cure, we may indeed consider this a question more for statesmen and governing bodies than for physicians." But what if statesmen and governing bodies, in virtue of the purely literary education which they receive, are grossly ignorant of the laws upon which health and disease attend, and refuse to be instructed? Sanitary reform is too useful and too practical to be a favourite with orators and sophists. After defining the three chief groups of so-called infectious diseases, the author subjects the "germ theory"—which has been somewhat too implicitly adopted by the public—to a rather severe criticism. The great fault of the theory is that it proves too much. Germs have been found, not merely in the fluids of men and other animals suffering from epidemics or from contagious diseases, not merely in the air of sewers and cesspools, but literally everywhere. If, therefore, these microbia are the cause of disease how does any mortal escape? It may, indeed, be contended that unlike true poisons, or rather poisonous chemical individuals, the poisons of disease, whether organised or not, do not act upon all human beings alike. The negro is proof against yellow fever, which sweeps away his white neighbours. The European inhabitants of the Fiji Islands were scarcely affected by that epidemic of measles which decimated the aborigines. Hence, then, it may be contended that admitting the very common occurrence of disease germs, they are capable of proving destructive only to persons of certain races, constitutions, or idiosyncracies.

A fact which strongly militates against the germ theory is brought forward in the fourteenth report of Dr. J. M. Cuningham, the Imperial Sanitary Commissioner of India (1879). He points out that cholera "almost invariably travels, not down, but up the great drainage channels of the country." The same has been, as far as we are aware, the case in Europe. The pestilence first appeared at the mouths of the Wolga, the Neva, the Elbe, the Tyne, &c., and did not descend to these points from the interior of the country. Now we have always been told that the *materies morbi* of cholera is to be found in the excreta of the patients which find their way into wells and streams and poison those who partake of the water. That typhoid fever has thus been communicated by polluted wells and by streams flowing from an infected district seems to be established beyond the reach of doubt, but the progress of disease against rather than with the stream cannot be thus accounted for.

The theory of Dr. Drysdale, with which Mr. Kingzett substantially agrees, is that contagious diseases, in the stricter sense of the term, are occasioned by diseased secretions thrown off by animals suffering from the same disease, and differing greatly among themselves in volatility and persistence. The miasms or malarious poisons consist, on the contrary, in secretions thrown off by diseased vegetables, or perhaps it would be better to say by vegetable matter in certain phases of decomposition.

As a fact inconsistent with the germ theory mention is made of the geography of disease, as studied by Mr. Haviland. In a country so limited in extent and so uniform in climatic conditions as England we should expect to find little difference in the diseases met with in its various districts. Such, however, is not the case: Lancashire and Cheshire are a nidus of scarlet fever, whilst, on the other hand, the Thames "flows through a vast cancer field." If we remember rightly, rabies in dogs and its consequence, hydrophobia, in the human subject are also very local and at the same time constant in their occurrence.

Mr. Kingzett declares himself very sceptical as to the benefits to be derived from the use of carbolic acid as a disinfectant. Admitting its power of destroying germs he considers this property of little value so long as infectants are not known to be not merely organic matter but living organisms. He quotes from the *Transactions of the Social Science Congress* for 1874 the statement of Dr. Dougall that a minim of vaccine lymph retained its virtues unimpaired after having been kept for thirty-six hours in the midst of a cubic foot of concentrated carbolic vapours. He declares also, on the authority of the *British Medical Journal* of February 21, 1874, that carbolic acid had proved so unsuccessful in arresting the spread of yellow fever at New Orleans and Mobile that it was even suspected of proving positively injurious. As we have often heard accounts of the very opposite character we prefer here to suspend judgment.

Mr. Kingzett is a firm believer in the disinfecting powers of the *Eucalyptus* and also of various species of conifers. Whilst we fully admit that the sanitary character of a country is almost invariably lowered by denuding it of trees, we cannot forget that we have known villages surrounded with pine forests and yet suffering year after year from malignant dysentery. This, however, is not improbably a directly parasitic affection, since it is very extensively warded off by using no water except such as has either been boiled or treated with alum.

Mr. Kingzett has no faith in ozone as a natural disinfectant, but attaches much more importance to hydrogen peroxide.

The work is a very valuable contribution to sanitary literature, and is calculated to disabuse the public mind of some errors.

Handels-Bericht von Gehe and Co., of Dresden. April, 1880.

An exceedingly thorough report on the imports, exports, stocks, and prices of drugs and chemicals, with an elabo-

rate essay on the causes of the prevailing commercial depression.

Practical Chemistry: the Principles of Qualitative Analysis. By W. A. Tilden, D.Sc., F.C.S., &c. London: Longmans, Green, and Co.

This is a little book of 108 pages, intended, as the learned author says, for beginners. In the first part, "the student is required to make himself familiar with the appearance and properties of a few substances with which he will afterwards constantly be dealing." In the second part we have a brief exposition of the analytical methods. As might readily be expected we observe no errors in the work, but we should be somewhat at a loss to point out any well-marked superiority which it enjoys over some of the multitudinous elementary works on chemistry which have appeared within the last few years.

Report on the Revision of the United States Pharmacopœia. Prepared and Compiled by Charles Rice. New York. 1880.

Among the alterations and improvements proposed we note the recommendation that the text of the new Pharmacopœia is to be drawn up in the English language. This is, in our opinion, a decided change for the better. The use of the Latin language in scientific works and documents is now merely a "survival" for which no valid reason can be brought forward. It is proposed that all chemicals of a definite character shall be accompanied by their formulæ, both on the old and the new notation. It appears that a report on the German Pharmacopœia pronounces the addition of such formulæ of little value, since they may soon have to undergo a reconstruction. Empirical formulæ give the greatest facilities for calculating the proportionate quantity of any constituent in a compound. Temperatures it is proposed to express both in degrees of Farenheit and Centigrade, and weights both in decimal and apothecaries' weights. It would surely be better still if in all recipes, for any purpose whatever, the proportions were expressed simply in "parts," which would be equally intelligible in all countries.

Sixteenth Annual Report of the Alumni Association, with the Exercises of the Fifty-ninth Commencement of the Philadelphia College of Pharmacy.

This report contains an account of the proceedings at the annual meeting of the College, with a list of the students who have graduated in pharmacy and of those who have taken exceptional honours.

Proceedings of the American Pharmaceutical Association at the Twenty-seventh Annual Meeting, held in Indianopolis, September, 1879. Philadelphia: Sherman and Co.

We have here a bulky and closely-printed volume well stored with important facts. Among the essays presented to the meeting we may mention that by P. C. Candidus on "The Increase of Volume on Dissolving Solids in Liquids." The author gives a table of the results obtained with fifty-two bodies, of which known weights were dissolved in known volumes of liquid—generally water—at 15·55°, the increase of bulk being measured in c.c. In ten cases no increase was observed.

Mr. G. W. Kennedy reported on the hygroscopic power of glycerin, which is capable of diluting itself very considerably on prolonged exposure to the air.

There is an extensive and well selected summary of chemical discoveries up to the summer of 1879, many of the paragraphs being taken from the Chemical News. A very large proportion of the matter in this section has no special connection with pharmacy.

The account of Mr. H. S. Wellcome's visit to the Cinchona Forests of South America is exceedingly interesting. The same remark applies to the paper on the flora of California. The so-called poison-oak—which, by the way, is not an oak but a *Rhus* (*Diversiloba*)—calls for chemical research. "To some persons the touch of the leaf is poisonous, causing an irritating eruption of the skin: its effect is sometimes felt even by passing to the leeward of the bush on a windy day, or going through the smoke of a fire in which it is burning. Poison-oak is the cause of a vast deal of suffering in California. It has been estimated that there are in this State near three thousand persons constantly affected with the cutaneous disease caused by this dreaded scourge."

CORRESPONDENCE.

A NEW PHENOL REACTION.

To the Editor of the Chemical News.

Sir,—I beg to give you a short account of a new reaction which has just been discovered and worked out by my friends Profs. V. Merz and W. Weith, in conjunction with their demonstrator, Dr. Invalta. Since, on the other hand, this reaction is evidently of very great importance, both in a scientific and a practical way, and since, on the other hand, the discoverers will only publish it for themselves when they have worked it out in more detail, this preliminary account of it will interest many of your readers. It is unnecessary to say that I write with the full permission and knowledge of Profs. Merz and Weith.

These chemists had found previously (*Berl. Ber.*, xii., 1925), that phenol on heating with zinc chloride is transformed into phenyl ether, and they had reserved for themselves the right of instituting similar experiments for the purpose of obtaining other aromatic substances. There suggested itself first, an attempt to replace the hydrogen, not only of phenols but also of amines, or of ammonia itself by the "remainders" of phenols, thus:—

$$C_6H_5-O\overset{\cdots\cdots}{\vdots}\underset{\cdots\cdots}{H+HO}\overset{\cdots\cdots}{\vdots} - C_6H_5 = C_6H_5-O-C_6H_5+H_2O.$$

$$(C_6H_5H)N\overset{\cdots\cdots}{\vdots}\underset{\cdots\cdots}{H+HO}\overset{\cdots\cdots}{\vdots} - C_6H_5 = (C_6H_5H)NC_6H_5+H_2O.$$

This supposition was entirely borne out by the following experiments.

A mixture of phenol and aniline-zinc chloride on heating produces abundant quantities of *diphenylamine*. This is probably the cheapest and most convenient way of preparing this compound as no pressure is required. Aniline-zinc chloride by itself furnished only traces of the secondary amine.

When phenol is treated with ammoniac-zinc chloride, aniline is produced, with a little diphenylamine, in very sensible quantity, but not so easily as in the first described case.

The smoothest and most abundant reaction takes place between β-naphthol and aniline-zinc chloride. The compound formed is *phenyl-beta-naphthylamine*,

$$N\begin{matrix}-C_{10}H_9\\-C_6H_5\\-H\end{matrix};$$

it crystallises in fine white needles, fusing at 108° C. similarly as with diphenylamine, its basic character is not very decided, so that the chlorhydric salt,—

$$N(C_6H_5)(C_6H_5)H.HCl,$$

is already decomposed by cold water.

This reaction opens out a field for very many applications; it will probably lead to tertiary amines, and no

doubt also to many compounds interesting in a practical point of view.—I am, &c.,

George Lunge.

Zürich, June 18, 1880.

CELLULOID.

To the Editor of the Chemical News.

Sir,—My attention has been drawn to an article on celluloid. Not having previously seen any notice of this chemical product, and being anxious to learn its nature, I shall feel obliged by your informing me regarding its composition and the process of manufacturing it.—I am, &c.

W. Donald.

IRISH BOG BUTTER.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xli., p. 205, is a report of a paper by Mr. John Plant, F.R.S., on "Bog Butter," in which he throws a doubt over its occurrence in kegs. At the same time, he states, he was "informed that specimens of veritable kegs of bog butter are to be seen in the Museum of the Royal Irish Academy and in the Museums at Edinburgh,"—statements which he does not appear to have attempted to verify. Lately I came across some back numbers of the *Athenæum*, and in one of September 18, giving a report of the British Association Meeting of 1852, I found a paper on "Irish Bog Butter" was read by Mr. J. A. Brazier, who states that the substance is found in Ireland and also in Scotland, and is "usually in small kegs," which he describes as of the "most primitive form of construction and about one foot in height and ten inches in diameter." The details of Mr. Brazier's research are not given.—I am, &c.,

W. A. Carius.

Leominster, Herefordshire.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 21, May 24, 1880.

Refrigerating Mixtures formed by an Acid and a Hydrated Salt.—M. Berthelot.—Refrigerating mixtures formed of hydrated salts along with acids, bases, or other salts are governed by the following theory:—The abnormal phenomenon manifested by these mixtures results from the struggle of the chemical energies with other energies. The chemical energies act in conformity with the principle of maximum work to determine an initial endothermic reaction of which all the others are the consequence. The thermic energies then intervene in an inverse direction to determine an absorption of heat in the fourfold form of dissociation (hydrated sodium sulphate), of disaggregation by the solvent (equilibrium between sodium bisulphate and water), solution (which plays merely an intermediate part in the case of sodium sulphate and concentrated hydrochloric acid), and liquefaction (water of crystallisation).

Action of Acids upon the Alloys of Rhodium with Lead and Zinc.—H. Debray.—Lead cannot be alloyed either with iridium or ruthenium. At high temperatures the two latter dissolve in lead, but crystallise out on cooling, and if the mass is dissolved in dilute nitric acid they are obtained in the form of a brilliant crystalline powder, insoluble in all acids and even in *aqua regia*. Platinum and rhodium combine with lead, giving out heat and light and forming crystalline alloys. When the lead is in large excess a very fusible alloy is obtained easily attacked by dilute nitric acid, which leaves a residue of platinum or rhodium combined with a certain quantity of lead. In case of platinum this residue is a true alloy, containing 11 per cent of lead and easily soluble in *aqua regia*. In case of rhodium after treatment with dilute nitric acid there remains P_6R_2 in small brilliant crystals, and a blackish matter lighter than the alloy and containing lead, rhodium, oxygen, and nitrogen. This compound is not a basic nitrite of rhodium and lead, but is more analogous to the nitriles of organic chemistry, though no known fact shows the possibility of hyponitrous acid being substituted for rhodium or lead.

Industrial Application of Solar Heat.—A. Mouchot.—The author has performed by means of solar heat a number of chemical operations on a practical scale. He enumerates the calcination of alum, the preparation of benzoic acid, the distillation of sulphuric acid, the production of wood charcoal in closed vessels, &c.

Combinations of Alcohols with Baryta and Lime: Products of the Decomposition of these Compounds by Heat.—A. Destrem.—Absolute alcohol combines readily with baryta and lime if brought in contact with them in closed vessels at 150° to 175°. The compound of ethylic alcohol and baryta gives about 300° ethylene, and hydrogen in about equal volumes. With amylic alcohol the process is similar, amylene being obtained in place of ethylene. The decomposition of the lime compounds is different. The carbide, C_nH_{2n}, is not liberated, and the products are hydrogen and a light liquid not yet examined. Anhydrous glycerin solidifies on being heated to 500 with baryta or quicklime. The lime compound on decomposition by heat yields water, hydrogen, carbonic acid, and a compound of carbon, hydrogen, and oxygen.

Reactions of Ammoniacal Salts with Calcium Carbonate.—M. Nivet.—In soils and in waters there takes place a double decomposition, the result of which is a loss of ammonia, the greater the lower is the absorptive power of the soil.

MISCELLANEOUS.

Tables of Spirit Gravities.—A complete series of tables of Spirit Gravities, by Dr. Thos. Stevenson, is preparing for publication by Mr. Van Voorst. This work will doubtless be appreciated by those engaged in analysis of alcoholic liquids.

Society of Arts.—The Council of this Society have awarded medals to the following gentlemen for papers read during the session which is just over:—Major-General H. Y. D. Scott, C.B., F.R.S., for his paper on "Suggestions for Dealing with the Sewage of London;" A. J. Ellis, F.R.S., for his paper on "The History of Musical Pitch;" John Spark, for his paper on "Recent Advances in the Production of Lambeth Art Pottery;" Henry B. Wheatley, F.S.A., for his paper on "The History and Art of Bookbinding;" W. Holman Hunt, for his paper on "The Present System of Obtaining Materials in use by Artist Painters, as compared with that of the Old Masters;" Thomas Fletcher, for his paper on "Recent Improvements in Gas Furnaces for Domestic and Laboratory Purposes;" John C. Morton, for his paper on "The Last Forty Years of Agricultural Experience;" Prof. Heaton, F.C.S., for his paper on "Balmain's Luminous Paint;" Captain Abney, R.E., F.R.S., for his paper on "Recent Advances in the Science of Photography."

TO CORRESPONDENTS.

J. Schwartz.—Caustic soda is now made at most large alkali works.

THE JOURNAL OF SCIENCE

for June (Price 1s. 6d.), includes—

Insanity and its Difficulties.
The History of Antozone and Peroxide of Hydrogen. By Albert R. Leeds, Ph.D.
The Origin of Falling Motion. By Charles Morris.
The Aurora.
Flighty Aspirations. By Fred. W. Brearey, Hon. Secretary to the A.S.G.B.
Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

SOUTH LONDON SCHOOL OF PHARMACY.

Special advantages are offered to Private Students during the Vacation commencing the end of July, in every branch of Practical Chemistry, as applied to Manufactures, Agricultural and Commercial Products, Water, Gas, Food, &c.

For terms, personal or by letter, W. Baxter, Secretary, Central Public Laboratory, Kennington Cross, S.E.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

C. H. GIMINGHAM'S PATENT COMBINATION BLOWPIPE,

FOR AMATEUR & PROFESSIONAL GLASS-BLOWING, &c

AS USED IN L. CASELLA'S WORKSHOPS.

The difficulties of Glass-Blowing are reduced to a minimum by this instrument. It combines the use of the large or small flame and large Bunsen flame, the changes from one to the other being made in less than one second.

SOLE MAKER—

L. CASELLA, 147, Holborn Bars, London, E.C.

DAHL & CO.,

BARMEN (RHENISH PRUSSIA),

MANUFACTURERS OF

ANILINE AND NAPHTHALINE COLOURS.

SPECIALITY—Ponceau Naphthol-Reds as a Substitute for Cochineal.

Sole Agency and Depôt in England,

THEODOR BANG,

BENSON'S BUILDINGS, BASINGHALL ST., LEEDS.

To ANILINE and Other DYE MANUFACTURERS.—To be Sold by Tender, in lots, the LEASES of the Premises known as "The Star Chemical Works," Brentford, held for a term of forty years from Michaelmas, 1853, at a nominal rent of £28 per annum; and the "Star Chemical Works," Wandsworth Bridge Road, Fulham, occupying an area of 2a. 1r. 28p., and held for a term of ninety-nine years from 24th June, 1874, at a ground rent of £115 per annum (together with certain wharfage rights on the bank of the Thames, adjoining Wandsworth Bridge). Also, the Fixed and Loose PLANT, Stock and Effects, and Goodwill of the Business now being carried on at both the before mentioned premises.—Particulars, with Forms of Tender and conditions, may be had of Messrs. Munns and Longden, Solicitors, 8, Old Jewry, E.C; of Messrs. R. Mackay and Co., Public Accountants, 3, Lothbury, E.C.; and of Messrs. Frank Lewis and Co., Auctioneers, Valuers, &c., 95, Gresham Street, E.C.

CHEMICAL LABORATORY, Established by Dr. Muspratt (1848), and successfully carried on by the present proprietors, to be Sold. The Laboratories are replete with all modern conveniences, and have large class room attached.—Apply to College of Chemistry, 96, Duke Street, Liverpool.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

Established 1798.

ROBERT DAGLISH & CO.,

ENGINEERS, BOILER AND BRIDGE MAKERS, MILLWRIGHTS,

BRASS AND IRON FOUNDERS.

Manufacturers of every description of Condensing, or High-pressure Blowing, Pumping, Rolling, Winding, and Patent Steam-engines, of any required power, for Irrigating, Draining, Mining, Rolling Mills, or Water Works purposes, and Manufacturers of every description of Chemical, Colliery, Copper Ore, Gold Mining, Glass, and Rock-salt Machinery.

Black-ash Revolving Furnaces of the Most Approved Type.
Bessemer Steel-Rail Plant.
Compressing-Engines for Collieries, Iron Works, and Weldon's Patent Bleaching-Powder Process.
Caustic, Chlorate, Decomposing, Nitre, Nitro-Glycerine, Iodine Potash, Sulphur, Acid, and Oxalic Pans.
Gas Producers Patent for Heating and other Purposes.
Pyrites Burners for Irish, Norwegian, and Spanish Ores of Improved Construction.
Patent-Rousing Machinery for Brewers.
Retorts, Acid, Gas, Iodine, Nitric, Nitre, Nitro-Glycerine and Vitriol Refining.
Steam Superheaters improved for Oil, Tar, and Resin Refining.
Steam Sulphur Melter.
Stills for Oil, Resin, and Tar.
Wheels, Bevel, Mitre, and Spur Moulded on the Shortest Notice by Patent Machinery.
Makers of Mactear's Patent Carbonating Furnace, Jones and Walsh's Patent Sulphate of Soda Furnace, Parnell and Simpson's Patent Causticiser, and Kynaston's Patent Alum Plant.

Lists sent on Application.

Photographs, Plans, and other information supplied on receipt of Order.

ST HELEN'S ENGINE, BOILER, AND BRIDGE WORKS AND FOUNDRY,

LANCASHIRE.

BISULPHIDE OF CARBON,

CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,

161 162 163, Palmerston Buildings, London, E.C

THOMAS ADKINS & CO.,

SMETHWICK,

NEAR BIRMINGHAM

Manufacturers of Specially Prepared Red Lead for Flint-Glass Making.

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

JESSE FISHER & SON,

Phœnix Chemical Works Ironbridge.

CHEMICAL & PHYSICAL APPARATUS,

BOTTLES, PURE CHEMICALS,

REAGENTS, STANDARD SOLUTIONS

And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

MOTTERSHEAD & CO.,

7, Exchange Street and 10, Half Moon Street,

MANCHESTER,

INDEX.

ABSORPTION - SPECTRA, relation between the molecular structure of carbon compounds and their, 270
Acetate, action of sodium on phenylic, 222
and sub-acetate of lead, determination of acetic acid in the, 110
Acetic acid and potassic acetate, action of potassic bichromate upon, 36
determination of in the acetate and sub-acetate of lead, 110
Acetyl, determination of by means of magnesia, 101
Acetyl-urea and its derivatives, 197
Acetylen-dicarbonic acids, 122
Acid, alleged non-existence of pentathionic, 209
bioxy-fumaric, 172
boracic as a preservative, 152
carbolic, reddening of, 269
crystalline oxalic, 219
cymen-carbonic, 36
formation-heat of persulphuric, 159
gases, injury to vegetation by, 111
lapacic, 36
new method of preparing phenyl-glycolic, 36
para-nitro-phenyi-acetic, 35
preparation and derivatives of xylylic, 80
quinic, studies on, 208
rubin, 37
studies on persulphuric, 133
sulphuric, manufacture of, 16, 43, 47, 52, 67, 78, 263
vapours, noxious action of on vegetation, 14
Acids, acetylen dicarbonic, 122
acidimetry of coloured, 110
action of hydro-ferro- and ferricyanic acids upon amines, 123
certain mono-chloro-crotonic, 173
free mineral in vinegar, detec- of, 110
maleic and malic, from bibrom-propionic acid, 252
Ackroyd, W., the human eye as an automatic photometer, 179
Actinism of the sun's rays, measurement of the, 211
Ader, M., certain new experiments on magnetic attractions, 241
Ador, E., and F. Meier, preparation and derivatives of xylylic acid, 80
Æthan and æthylen, halogen derivatives of, 122
"Agenda du Chemiste" (review), 250
"Agriculture, Chemistry of" (review), 250
Air, action of upon peaty water, 245
analyses of, 97
influence of in the reduction of the ores of zinc, 220
Albumen n urine, quantitative and qualitative determination of, 122
putrefaction-products of, 252
Alcohol, certain properties of mixtures of methyl-cyanide with common, 218
cymen of cuminic 36
oxidation of by the ammoniacal binoxide of copper, 47
proportion of water in, 36
radicles, amido-acids with, 172
regulations concerning the sale of duty free for industrial purposes, 273
tables, 57, 70, 71, 100
Alcoholic fermentation, rapid, 140
liquids, coagulation-point of, 241
Alcohols, combination of with baryta and lime, 295
in unfermented fruit juices, 25
Alexandrowicz, W., note on the actual state of the determination of zinc, 279
Alizarin, iso-purpurin, and flavo-purpurin in mixtures, recognition of, 256
Alkalies in æthusa cynapium, 277
Alkalimetric determination of sulphates, 114, 158
Alkaline carbonates, platinum attacked by melting, 25
dicarbonates examination of, 160
hypobromites and hypochlorites, determination of urea by means of, 161
tri-sulpho-carbonates, decomposition of in the animal system, 122
Alkaloids, the, 255
artificial, 159, 220
notes on the, 63
of belladonna, datura, jusquiama, and duboisia, natural and mydriatic, 241
Allen, A. H., alcohol tables, 70, 100
artificial production of precious stones, 68
presence of nitrogen in iron, 231
Aluminium and magnesium, gases retained by occlusion in, 273
atomic weight and valence of, 212
of, and occluded hydrogen, 285
chloride and bromide, reactions taking place in presence of, 251
wires for the telegraph, 134
Amagat, E. H., change of form in glass tubes exposed to high pressures, 241
"American Pharmaceutical Association" (review), 294
American tantalates, analyses of some, 244
Amines, action of hydro-ferro- and ferri-cyanic acids upon, 123
Amido-acids with alcohol radicles, 172
Ammonia, action of mercury on solution of sodium in, 133
Ammonia and Leblanc soda, 102
behaviour of phenanthrenquinon with, 203
for atmospheric nitrogen, 208, 218, 229, 240, 259
from the nitrogen of the atmosphere and the hydrogen of water, 155, 195, 272
keeping salts of, 185
in plants, existence of, 241
preparation of water free from, 160
Ammoniacal salts, reaction of with calcium carbonate, 295
Ammonium carbonate, 251
citrate, reversion of phosphates soluble in, 173
nitrite, 252
Ampère's currents in soft iron, application of the pre-existence of, 58
Amphigen, reproduction of, 134
Amplifying small motions, 292
Anæsthetic, new, 154
Analyses of air, 97
of some American tantalates, 244
of the ash of eucalyptus wood, 248
Analysis, blowpipe, 133, 158
of children's food, 101
of milk, 230
of phosphates containing silica and fluorine, 101
of plants, proximate, 256
of water, 272
of wine and must, 159
of women's milk, 102
"Analysis, Water, for Sanitary Purposes" (review), 206
Analysts, Society of Public, 46
Analytical chemistry, electric current in, 213
Anethol derivatives, composition of the, 251
Animal charcoal in the sugar manufacture, suppression of, 220
life, influence of manufacturing refuse on, 161
tar, carbons obtained from, 220
Animals, influence of fattening upon the constitution of the fats formed in their tissues, 283
Anschütz, R., fumaric and maleic ether, 172
Ansdell, G., physical constants of liquid hydrochloric acid, 75
Anthracens, use of the spectroscope in discriminating, 52, 95, 117
Anthraquinon, constitution of, 92
Antimony, atomic weight of, 197, 201
Apparatus for object lessons, lectures to schoolmistresses on, 130
Aqueous dimethylamin, reactions produced by upon metallic solutions of, 173
Arable soils, potash contained in the clay of, 70
Armstrong, H. E., action of iodine upon oil of turpentine, 34
note on camphydrene, 290
Aromatic aldehyds, synthesis of 172
Arsenic, chemical cause of the poisonous character of, 122
detection and estimation of, 177
in water colours, 110
new method of determining, 109
volatilising point of metallic 189
Arsenical and antimonial compounds solution, 110
vapours, contamination of atmospheric air with, 3
Arseniferous bismuth with nitric acid, behaviour of, 23
Artificial alkaloids, 220
Arts, Society of, 59, 87, 134, 225
Atkinson, R. W., action of the new diastase, eurotin, on starch, 169
Atmosphere, ammonia from the nitrogen of, 272
Atmospheric air with arsenical vapours, contamination of, 3
nitrogen, ammonia from, 208, 218, 229, 240, 259
oxidation of phosphorus, formation of ozone by the, 76
Atomic weight and valence of aluminium, 212
of antimony, 197, 201
weights, reciprocal relations between, of the elements and their properties, 283
Atomistic periodicity, history of, 203
Auerbach, Dr., influence of manufacturing refuse on animal life, 161
G., azo and naphthol colouring-matters, 283
Auric chloride, reduction of, 13
Automatic mercurial pump, 279
Ayrton and Perry, Profs., theory of terrestrial magnetism, 91
Azo and naphthol colouring-matters, 283
Azo-benzene, action of zinc-ethyl on, 270
Azo-colours, some new, 117
Azo-compounds, certain, 219

BACTERIA of putrefaction, chemical composition of, 23
Baeyer, A., and O. R. Jackson, synthesis of the homologues of hydrocarbostyril and chinolin, 251
of methyl-ketol, 252
Balling, A. M., separation of gold by quartation with zinc, 173
C., determination of silver in galena, 42
Balmain's luminous paint, 81, 135
Balsohn, M., synthesis of ethyl-benzin, by means of ether and benzin, 160
and C. Friedel, transformation of bromised styrolen into methyl benzoyl, 160

Barbieri, J., and E. Schulze, decomposition of albumen in the sprouts of pumpkins, 23
Bardy, M., methylated products and the preparation of pure methylic alcohol, 220
Barium binoxide, active oxygen in, 215
Barker, G. F., and H. A. Rowland, efficiency of Edison's electric light, 200
Barley, W., phoneidoscope, 292
Barnes, J., error in vapour-density determinations, 260
Barometer vaccum, on a simple method of determining vapour-densities in, 271
Barth, L., and M. Kretschy, researches on picrotoxin, 229
Base, a new, 219
Baswitz, M., diastase, 35
Battery, application of the Tommasi, 58
Baudrimont, E., action of potassium permanganate upon potassium cyanide, 48
Baudrowski, E., acetylen-dicarbonic acids. 122
Bayle, O., and R. Poutigga, new process for bleaching vegetable fibres, 263
Bechi, G., certain constituents of tar, 80
Bees, disease among, 132
Beet-root, propagation between the sugar and the mineral, and nitrogenous substances in, 219
Bell, C. A., on a simple method of determining vapour-densities in the barometer vacuum, 271
J. C., unfermented wine case, 70
Belladonna, datura, jusquiama, and duboisia, natural and mydriatic alkaloids of, 241
Benzene, artificial colouring-matters derived from, 225
Benzines, coal, and petroleum, 263
Benzo-nitrite, action of zinc-ethyl on, 270
Benzoyl-chloride and benzo-trichloride, action on phenols, 284
Berchelmann, G. A., erroneous test for kirshwasser, 230
Berger, F., guanidins of ortho-toluidine, 35
Berkley, P. A., notes on magnesian limestone bricks, 5
Bernhardt, W., alkalies in Æthusa cynapium, 277
Bert, P., and M. d'Arsonville, on a microphonic apparatus receiving words at a distance, 183
Berthelot, M., action of organic solvents upon sulphur and metallic sulphides, 23
of oxygenated water upon silver oxide, 183
certain compounds of the halogens, 240
chemical stability of matter in sonorous vibrations, 171
copper hydride, 47
decomposition of oxygenated water, 159
of potassium permanganate by oxygenated water, 195
formation-heat of gaseous chloral hydrate, 171
of persulphuric acid, 159
heat of formation of chloral hydrate, 79
of gaseous chloral hydrate, 47
protochloride of copper, 11
reciprocal displacements of the halogens, 250
refrigerating mixtures formed by an acid and a hydrated salt, 295
relation between the heat of solution and the heat of dilution in complex solvents, 10
researches on so-called hydride of copper, 22
saccharosis, 10
silver teroxide, 195
Berthelot, M., stability of oxygenated water, 250
studies on persulphuric acid, 133
and M. Vieille, explosive properties of mercury fulminate, 261
Bertrand, M. A., active oxygen in barium binoxide, 215
Betorcinol and some of its derivatives, 168, 175
Binnendijk, Dr., poisonous properties of phenol, 24
Binon, J., influence of air in the reduction of the ores of zinc, 220
Binoxide of copper, oxidation of alcohol by the ammoniacal, 47
Binz, C., and H. Schulz, chemical cause of the poisonous character of arsenic, 122
Bioxy-fumaric acid, 172
Birmingham, endowment of research in, 131
Philosophical Society, 131
Bismuth, behaviour of arseniferous with nitric acid, 23
cadmium, and copper, qualitative determination of, 263
method for estimating volumetrically, 153
Blanchard, M. Emile, report on the scientific researches of the members of the learned societies in the departments published in the year 1879, 284
Bleunard, A., on legumin, 273
products of the splitting-up of proteic bodies, 184
Blowpipe analysis, 133, 158, 250
combination, for glass-working, 253
"Blowpipe Analysis, Alphabetical Manual" (review), 249
Blue flame in coal-fires, 22, 47
Böckmann, F., "On Explosives" (review), 194
Bodies absolute expansion of liquid and solid, 35
new and old views on the nascent state, 1
Bœke, T. D., detection and estimation of arsenic, 177
Bog butter from Ireland, 205
Irish, 295
Boiler protector, corrosion of metallic zinc when used as, 102
Bolton, H. C., ancient methods of filtration, 54
Bone-black, absorption of sugar by, 287
Boracic acid as a preservative, 152
Borneol and camphor, camphen of, 252
Boron and silicon fluorides, action of water on, 134
Böttinger, E., decomposition of mesoxalic acid by hydrogen sulphide, 48
Boucha-dat, G., action of the hydracids upon isopren, 48
Bourgeois, L, and A. Verneuil, artificial production of a crystalline iron arseniate, 173
Bourgoin, E., electrolysis of malonic acid, 183
Bourrières, M., application of the Tommasi battery, 58
Boutigny, P. H., laws which govern matter in the spheroidal state, 273
Braga, J. F., analyses of some hair-dyes, 278
Braithwaite, W. and J., "Retrospect of Medicine" (review), 109
Brasseur, A., the mean composition of the saliferous waters and of the various products of the salt works of St. Leopold, near Volterra, and the theory of the extraction of salt there practised, 283
Brauner, B., action of silver cyanate upon isobutylic iodide, 36
Bredt, J., and R. Fittig, nature of pyroterebic acid, 209
Brenken, O., examination of mineral lubricating oils, 25
Bricks, magnesian limestones, 5
Brieger, L., skatol, 80
Burq, Dr., antisepticity of copper, 284
Brom-dimethyl-aniline, 35
Bromine and iodine, detection and determination of chlorine in presence of, 280
chlorine, and iodine, agreement of the oxygen-stere, 5·4, with the stere of, 263
relative replaceability of in the mono-brom-benzyl bromides, 146
vapour, density of at a yellow heat, 151
Bromised styrolen, transformation of into methyl-benzoyl, 160
Bronze, tungsten, 123
Brown, H. T., and J. Heron, history of starch and its transformations, 22
Brühl, J. W., chemical constitution of organic bodies, 208
Bruylants, G., method of preparing hydrobromic and hydriodic acids, 80
Buisine, A., and E. Duvillier, formation of tetra-methyl-ammonium nitrate, 241
Burrs in wool, destruction of, 24
Butter, detection of oleo-margarin, 77
two ancient samples of, 46
Butyl-chloral hydrate, dissociation of, 273

CADMIUM in zinc, separation and estimation of, 28
Cahours, A., and A. Etard, new derivative of nicotin, 133
Cailletet, L., compression of gaseous mixtures, 101
O., detection of copper in olive oil, 160
Calcium carbonate, reaction of ammoniacal salts with, 295
fluoride, crystalline, 24
oxalate in plants, signification of, 160
Camphen of borneol and of camphor, 252
Camphydrene, note on, 290
Cane-sugar, detection of starch-sugar mixed with, 221
Cantoni, G., constitution of liquids, 284
Carey, E., proposed Society of Industrial Chemistry, 260
Carbohydrates, 48
Carbolic acid, reddening of, 269
Carbon acids of pyridin, 220
compounds, determination of nitrogen in, 223
relation between their molecular structure of and their absorption-spectra, 270
crystallisation of, 13
crystallised, in abstract, 111
estimation of in steel, 17, 152, 229, 250
in soils, determination of, 290
Carbons obtained from animal tar, 220
Carbonate, ammonium, 251
Carbonates, thermo-chemical researches on the, 80
Carbonic acid, proportion of in the air, 282
cymen, 36
reduction of by phosphorus at common temperatures, 92
oxide as an agent for the preservation of meat, 122
in the products of the combustion of coal-gas, 146
Carisbrooke Castle well-water, 10, 57
Carius, W. A., Irish bog butter, 295
Carnelly, T., and W. C. Williams, melting- and boiling-points of certain inorganic substances, 45
Mendelejeff's periodic law, 48
vapour-density of stannous chloride 35
Casamajor, P., action of bone-black on solutions of pure sugar, 66
detection of starch-sugar mixed with cane-sugar, 221
Catalytic force and the nascent state, 208
Cats, electricity of, 59
Celluloid, 295
Cements and lubricants, quantitative determination of fats and resins in, 36
Cerium, volumetric determination of, 231
Certes, A., glycogenesis in infusoria, 70
"Ceylon Coffee, Soils, and Manures" (review), 217
Chambrier, M., new electro-magnet, 159
Characin and palmellin, 22
Charcoal, influence of the nature of the upon the electric light, 70
Chemical affinity in terms of electromotive force, 108
"Chemical Analysis, a Course of Qualitative, by the late W. G. Valentin" (review), 282
Chemical calculations, use of slide rule for, 33
cause of the poisonous character of arsenic, 122
committee of the Industrial Society of Mulhouse, 11
composition of the bones in the arthropathy of ataxic cases, 22
constitution of organic bodies, 208
curves, illustration of, 191
elements, periodic law of the, 2, 27, 39, 48, 49, 61, 71, 83, 93, 106, 113, 125
equilibrium, 168
Institute of the University of Strasburg, 208
manufactures of the South of France, notes on, 273
photometer, new, 122
repulsion, 40
Society, 44, 76, 98, 100, 120, 143, 167, 191, 222, 245, 269, 290
of Newcastle, 5, 32, 132, 179
Russian, 160, 173
specimens, 274
stability of matter in sonorous vibrations, 171
"Chemical Medicine, Annals of" (review), 10, 20
"Chemiste, Agenda du" (review), 217
Chemistry, electric current in analytical, 213
Institute of, 147, 156
"Chemistry of Agriculture" (review), 250
"Chemistry, Qualitative" (review), 19
"Chemistry, Questions on" (review), 19
"Chemists' and Druggists' Diary for 1880" (review). 21
Chemists, proposed Society of, 243, 260
Chevreul, E., physical functions of leaves, 48
Childrens' food, analysis of, 101
Chloral hydrate, combination-heat of, 159, 171
dissociation-tension of, 70
heat of formation of gaseous, 47, 79
and bichromate of potash, oxidising value of, 21
Chloride, auric, reduction of, 13
platino-potassic, determination of potassium as, 11
of zinc as a reagent for alkaloids, 110
vapour-density of stannous, 35
Chlorine, contribution to the knowledge of, 135
density of at high temperatures, 92
detection and determination of in presence of bromine and iodine, 280
gas, volatility of platinum in,

Chlorophyll, crystalline, 11
Cholic acid, oxidation of, 172
Chrome, sulphides and selenides of, 219
Chromium and tungsten in steel and in iron alloys, 31
determination of, 222
Ciamician, G. L., and H. Weidel, carbons obtained from animal tar, 220
Cinchona barks, 252
Coal and petroleum benzines, 263
condition in which sulphur exists in, 201
fires, blue flame in, 22, 47
Coal-gas, carbonic oxide in the products of the combustion of, 146
heating power of, 41
products of combustion of, 169
production of ozone during the combustion of, 98
Coal-tar industry, progress of for the last ten years, 283
Cobalt and manganese, determination of, 184
nickel, determination of, 15
researches on, 74
electrolytic determination of, 25
"Coffee, Soils, and Manures, Ceylon" (review), 217
Cohné, S., alcohol tables, 57, 78
Cole, G., new metallic compound, 87
Colours, non-poisonous, 282
Colson, M. A., reversion of phosphates soluble in ammonium citrate, 173
Comstock, W. J., analyses of some American tantalates, 244
Conche, E., photography of the solar spectrum, 195
Condensers, use of tempered glass for, 159
Conechy, E. G. M., volatilising-point of metallic arsenic, 89
Cooke, J. P., atomic weight of antimony, 201
Copper, antisepticity of, 284
bismuth, and cadmium, qualitative separation of, 263
detection on of in olive oil, 160
electrolytic, determination of, 25
hydride, 47, 58, 70
in silk, 284
protochloride of, 11
reducing agents in refining and obtaining copper alloys, 272
researches on the so-called hydride of, 22
"Cotton Goods, Sizing of" (review), 9
Cotton goods sizing, 34
Couttolenc, M. G., automatic mercurial pump, 279
Crafts, J. M., density of certain gases at high temperature, 134
density of chlorine at high temperatures, 92
and F. Meier, density of iodine at high temperatures, 195
Crookes, W., a fourth state of matter, 275
Crystalline chlorophyll, 11
oxalic acid, 219
Cucumis anguira, colouring matter of, 36
Cumol, synthesis of, 219
Cupric test-pellets for sugar, 63, 78, 91
Cuprous chloride, formation-heat of, 251
Curares, plants which serve as the basis of the different, 79
Cyanallyl, 80
Cyanogen compounds, formation of graphite by the decomposition of, 283
formation-heat of, 251
Cymen-carbonic acid, 36
Cymen of cuminic alcohol, 36
Cymene, examination of terpenes for, 291

DALLICAN, M., quantitative determination of stearin and olein in tallow, 283
Danesi, L., action of potassic bichromate upon acetic acid and potassic acetate, 36
Danos, winter climate of, 293
D'Arsonval, M., new voltaic condenser, 84
D'Arsonville, M., and P. Bert, microphonic apparatus receiving words at a distance, 183
Davis, G. E., carbon in steel, 229
proposed Technical Society, 261
"Sizing and Mildew in Cotton Goods" (review), 9
testing of vitriol chamber exits, 69, 146, 188
De Backer, H., electric lighting, 220
Debray, H., action of acids on alloys of rhodium with lead and zinc, 295
De Fonvielle, W., dependence of two electro-magnetic gyroscopes submitted to the same induction circuit, 262
Defresne, T., researches on pytalin and diastase, 22
Degener, P., volumetric determination of phenol, 222
De Koninck, L., platinum attacked by melting alkaline carbonates, 25
Delachanal and Vincent, MM., certain properties of mixtures of methyl-cyanide with common alcohol and methylic alcohol, 218
Delff's H., behaviour of sulphuretted hydrogen with the salts of the heavy metals, 279
Delplace, G., comparison of the apparatus for the concentration of sulphuric acid according to the systems of Delplace and Prentice, 274
Delafontaine, MM., new metals from gadolinite and Samarskite, 72
De Lépinay, MM., accidental double refraction, 146
Demole, E., partial synthesis of milk-sugar, 48
De Negri, A. and E., colouring matter of cucumis anguria, 36
Denzel, J., halogen derivatives of æthen and æthylen, 122
Deprez, M., measurer of energy, 219
Des Cloizeaux, M., crystalline form of magnesium, 282
Destrem, A., combinations of alcohols with baryta and lime, 295
Deville, H. Ste.-Claire, motion produced by the diffusion of gases and liquids, 58
Diamond, artificial production of the, 4, 97, 106
in an ophitic rock from South Africa, 46
Dibrom-anthraquinons, 45
Diastase, 35
action of upon starch-paste, 92
and maltin, active matter in, 25
and pytalin, action of, 160
researches on, 22
Dimethyl-meta-toluydin, certain derivatives of, 35
Dimethyl-naphthyl-amin and naphtho-quinon, 209
Dimethyl-para-phenylen-diamin, 35
Dinitro-ethylic acid, new method of preparing, 291
Dioxethylen-amines, methylated, 77
Dipara-tolyl-guanidine, action of nitric acid on, 290
Diphenyl-di-imido-naphthol, 251
Disease, propagation of, 110
Ditte, M. A., action of metallic nitrites upon mono-hydrated nitric acid, 23
refrigerating mixtures formed by an acid and a hydrated salt, 283
Dobbin, L., reactions of tertiary isobutylic iodide, 77
Dœbner, O., action of benzoyl chloride and benzo-trichloride upon phenols, 284
Donald, W., celluloid, 295
Donath, E., detecting and determining iodine in presence of bromine and chlorine, 110
determination of cobalt and nickel, 15
solution of arsenical and antimonial compounds, 110
Dott, D. B., notes on solubility, 165
Dor, H. H., phenomena of vision, 146
Doubrava, S., movement of plates between the electrodes of the Holtz machine, 185
and E. Mach, electric perforation of glass, 184
Dreschel, E., urea-palladious chloride, 23
Drewsen, J., new method of determining the value of zinc-powder, 161
Dublin waters, examination of some, 62
Dubrunfaut, M., active matter in maltin and diastase, 25
mechanical equivolent of fat in cattle being fattened, 134
Ducretet, M., tempered glass for condensers, 159
Dufour and Rouaix, MM., pallet for the assay of oils, 24
Dumas, M., gases retained by occlusion in aluminium and magnesium, 273
Dunnington, F. P., new form of instrument for determination of specific gravity, 154
Dupré, Dr., detection of foreign colouring matters in wine, 269
Duvillier, E., and Buisine, formation of tetra-methyl-ammonium nitrate, 241
Du Moncel, T., influence of the nature of the charcoal upon the electric light, 70
Dvorak, V., method for recognising the optical difference of transparent bodies. 230
Dwars, M., separation of quinine from strychnine, 160

EARTH, edible, from Japan, 187
Eder, J. M., new chemical photometer, 122, 252
reducing properties of potassic ferro-oxalate, 230
Edison's electric light, 182
horse-shoe lamps, electrical measurements of, 199
"Egasse" disinfectant, the, 25
Eichler, E., octyl derivatives, 36
Eisenberg, L. J., action of hydro-, ferro-, and ferri-cyanic acids upon amines,
Ekin, C., "Potable Water" (review), 280
water analysis, 272
Electric burner, new, 48
current in analytical chemistry, 213
discharges in rarefied gases, analysis of the luminous phenomena produced by, 195
experiment unexplained, 81
lamp, smoke of an, 32
light, Edison's, 182
efficiency of, 200
influence of the nature of the charcoal upon the, 70
lighting, 220
perforation of glass, 184
regulation of time in Paris, 195
sparks produced by discharges of condensers, thermic laws of, 194
thermic laws of, 70
Electrical Company, Universal, 252
measurements of Edison's horse-shoe lamps, 199
Electricity of steel, 81
of cats, 59
Electricity, source of the force exciting, 230
"Electricity Tommasi," 58
Electrodes of the Holtz machine, movement of the plates between the, 185
Electrolysis, action of upon terebenthen, 172
of malonic acid, 183
Electrolytic determination of cobalt, nickel, and copper, 25
of metals, 280
Electro-deposition of lead, 209
Electro-magnetic gyroscopes, dependence of two submitted to the same induction-circuit, 262
Electro-magnet, new, 159
"Electro-plating" (review), 19
Electro-motive force, chemical affinity in terms of, 108
Elements, chemical, periodic law of the, 2, 27, 39, 48, 49, 61, 71 83, 93, 106, 113, 125
Elsässer, E., galvanic conductivity of metallic alloys, 184
Emmerich, R., infection with town sewage and water from manufactories, 184
Endemann, H., boracic acid as a preservative, 152
Energy, measurer of, 219
Engel, M., dissociation of butyl-chloral hydrate, 273
and M. Moitessier, dissociation-tension of chloral hydrate, 70
Engler, C., apparatus for testing petroleum, 283
solubility of the metals in petroleum, 284
Etard, A., and A. Cahours, new derivatives of nicotine, 133
Ether and benzin, synthesis of ethyl-benzin by means of, 160
Ethereal salts of phenyl-acetic acid, action of sodium on, 222
Ethyl-benzin, limited oxidation of, 160
synthesis of by means of ether and benzin, 160
Ericin, 146
Erzbach, W. M., luminous nature of phosphorus, 92
Eucalyptus wood, analyses of the ash of, 248
Euphorbiaceæ, gum of the, 25
Eupittonic acid and pittacal, 122
Evans, J. C., action of zinc-ethyl upon benzo-nitrile, 270
Exner, F., theory of inconstant galvanic elements, 227
"Explosives" (review), 194
Explosives, decomposition of certain in closed vessels, 273, 282

FAT, mechanical equivalent of in cattle being fattened, 134
Fats and resins in cements and lubricants, quantitative determination of, 36
Fauconnier, A., determination of urea by means of alkaline hypochlorites and hypobromites, 161
"Fermentation, Studies on" (review), 20
Fernet, E., analysis of the luminous phenomena produced by electric discharges in rarified gases, 195
Ferric chloride, method of detecting free hydrochloric acid in a solution of, 196
Fileti, M., and A. Piccini, decomposition of hydrochlorate of ethylamin by heat, 36
Filtration, ancient methods of, 54
Fish, danger to from the liquid refuse of manufactures, 122
Fisher, E., hydrazin compounds, 23
Fittig, R., polymerised non-saturated acids, 34
and J. Bredt, nature of pyroterebic acid, 209
"Flashing," phenomenon of in assays of gold, 126, 131

Fletcher, J., examination of some Dublin waters, 62
Fleischer, M., valuation of reverted phosphates, 283
Fluids, some effects of vibratory motion in, 108
Formic acid, 185
synthetic formation of, 219
Foster, W., contamination of atmospheric air with arsenical vapours, 3
Fourth state of matter, 275
Fonvielle, W., electro-magnetic gyroscope, 251
Francken, J., suppression of animal charcoal in the sugar manufacture, 220
Frankland, E., action of organo-zinc compounds upon nitriles and their analogues, 270
zinc-ethyl upon benzo-nitrile, 270
and C. C. Graham, new method of preparing dinitro-ethylic acid, 291
and H. K. Tompkins, action of zinc-ethyl on phenyl-aceto-nitril, 291
and Miss L. Halcrow, action of air upon peaty water, 245
"Water Analysis for Sanitary Purposes" (review), 206
Franchimont, A. P. N., carbo-hydrates, 48
French patent law, 262
Fresenius, R., determination of sulphur in pyrites, 173
Fresnel's interference phenomena, true theory of, 184
Friedel, C., and M. Balsohn, transformation of bromised styrolen into methyl-benzoyl, 160
Fringes, interference, new, 134
Friswell, R. J., artificial colouring matters derived from benzene, 225
Fromme, C., changes in the specific gravity of steel, 70
Frost of December, 1879, 99
Fruit-juices, unfermented, alcohols in, 25
Fumaric and maleic ether, 172

GADOLINITE and samarskite, new metals from, 72
Gaiffe, A., Thomson's galvanometer, 63
Galena, determination of silver in, 42
Galvanic conductivity of metallic alloys, 184
elements, theory of inconstant, 227
Galvanometer, Thomson's, 63
Gardenin, 252
Gas companies v. tar distillers, 289
purification of, 155
tar, distillation of, 289
Gaseous mixtures, compression of, 101
Gases and liquids, motion produced by the diffusion of, 58
at high temperatures, density of certain, 134
retained by occlusion in aluminium and magnesium, 273
solubility of solids in, 103, 133
Gautier, A., crystalline chlorophyll, 11
isomers of phloro-glucine, 262
Gelose, 251, 253
Gerber, N., and P. Radenhausen, analysis of children's food, 101
analysis of milk, 230
analysis of women's milk, 102
Giacosa, P., new method of preparing phenol glycolic acid, 36
Gibertini, Dr. D., reciprocal relations between the atomic weights of the elements and their properties, 283
Gigli, T., santonin contaminated with strychnin, 283
Gilbert, H., analysis of phosphates containing silica and fluorine, 101
Gimingham, C. H., combination blowpipe for glass working, 253
Girdwood, G. P., transparency of gold, 133
Glasgow Philosophical Society, 236
"Glasgow Sewage" (review), 207
Glassford, W. O., cupric test-pellets, 91
Glass, soluble, reactions of, 146
tubes exposed to high pressure, change of form in, 241
use of tempered for condensers, 159
weights, new, 110
Glass-working, combination blowpipe for, 253
Glycerin, determination of in wines, 273
production of, 283
Glycogenesis in infusoria, 70
Goes, B., diphenyl-di-imido-naphthol, 251
Gold, cupelled, influence of superfusion on the molecular arrangement of, 266
phenomena of "flashing" in assays of, 126, 131
reduction of by hydrogen in presence of platinum, 116
separation of by quartation with zinc, 173
transparency of, 133
Gouy, M., new interference fringes, 134
theory of circular double refraction, 262
Gorceix, M., martite of Brazil, 134
Graebe, C., occurrence of paraleucanilin in the magenta melt, 146
and W. Knecht, synthesis of phenyl-naphthyl-carbazol, 146
Graham, C. C., and E. Frankland, new method of preparing dinitro-ethylic acid, 291
Grandhomme, Dr., "The Tar-Colour Works of Messrs. Meister, Lucius, and Brüning" (review), 216
Grant, Mr., induction in telephonic circuits, 56
Graphite, formation of by the decomposition of cyanogen compounds, 283
Greene, W. H., new synthesis of saligenin, 58
preparation of the iodine and bromine derivatives of benzin, 58
Gréhaut, M., carbonic oxide in the products of the combustion of coal-gas, 146
Griess, P., amido-acids with alcohol radicles, 172
Grimshaw, H., water of the Carisbrooke Castle well, 57
Grossmann, J., alkalimetric determination of sulphates, 114, 183
Groves, C. E., determination of nitrogen in carbon compounds, 223
and J. Stenhouse, betorcinol and some of its derivatives, 168, 175
gardenin, 252
preliminary note on some orc no de ivatives, 286, 2 o
Guanidins o orth -toluidine, 35
Guebhard, A., coloured rings produced on the surface of mercury, 10
new phenomenoscopic process by means of coloured rings, 48
Guetta, G., reduction of nitrates during metallic substitutions, 196
Gum, new reaction with, 273
of the euphorbiaceæ, 25
Gustavson, G., reactions taking place in presence of aluminium chloride and bromide, 251
Gutzeit, M., presence of alcohols in unfermented fruit juices, 25
Gyroscope, electro-magnetic, 251
Gyroscopes submitted to the same induction-circuit, dependence of two magnetic, 262

HAGENBACH, E., the law of Stokes, 184
Hager, H., reddening of carbolic acid, 269
Hair-dyes, analyses of, 278
Halcrow, Miss L., and E. Frankland, action of air upon peaty water, 245
Halogen derivatives of æthan and æthylen, 122
Halogens, certain compounds of the, 240
reciprocal displacements of the, 250
Hammerl, H., action of water upon silicon and boron fluorides, 134
"Handels-Berichte von Gehe and Co. of Dresden" (review), 293
Hannay, J. B., and J. Hogarth, solubility of solids in gases, 103
artificial formation of the diamond, 106
Hardtung, E., and J. Post, products of the sulphurisation of isomeric nitramido- and diamido-benzols, 219
Harmann and Reimer, MM., vanillin, 24
Hartley, Prof., on the relation between the molecular structure of carbon compounds and their absorption-spectra, 270
W. N., on the examination of terpenes for cymene, 291
Hautefeuille, P., new property of the vanadiates, 218
reproduction of amphigen, 134
simultaneous reproduction of orthose and quartz, 219
two new sodium silico-titanates, 241
Heat, decomposition of the hydrochlorate of ethyl-amin by, 36
of solution and the heat of dilution, relation between in complex solvents, 10
Heaton, C.W., Balmain's luminous paint, 135
Hebner, O., "new" methods, 158
Heighman, W., "Photographic Printers' Assistant (review), 20
Henry, L., dry distillation of sodium trichlor-acetate, 35
Herman, W. D., volatilisation of solids in vacuo, 191
Heron, J., and H. T. Brown, history of starch, 22
Herzfeld, A., action of diastase upon starch paste, 92
Herzig, J., and H. Weidel, compounds from animal tar, 122
Hesse, O., cinchona barks, 252
studies on quinic acid, quinon, and on connected bodies, 208
Heumann, H., on ultramarine, 284
K., ultramarine compounds, 23
Hippuric acid in the urine of the herbivora, source of, 23
Hodgkinson, W., action of sodium on ethereal salts of phenyl-acetic acid, 222
"A Course of Qualitative Chemical Analysis," by the late W. G. Valentin (review), 282
and W. H. Perkin, action of sodium of phenylic acetate, 222
Hoffmann, R., ammonia and Leblanc soda, 102
Hofmann, A. W., further particulars on pittacal and eupittonic acid, 122
Hogarth, J., and J. B. Hannay, solubility of solids in gases, 103
Hollway, J., dephosphorisation of iron, 228, 237
Hoogewerff, S., and W. A. van Dorp, carbon acids of pyridin, 220
Houzé, A., new process for the manufacture of sulphuric acid, 263
Houzeau, A., proportion of iron in the mineral waters of Rouen, 262
Hughes, J., "Ceylon Coffee Soils and Manures" (review), 217
Hungary, wine manufacture in 110
Hutchinson, C. C., separation and estimation of cadmium in zinc, 28
Hydracids, action of upon isopren, 48
Hydrate, dissociation-tension of chloral, 70
heat of formation of chloral, 79
Hydrazin compounds, 23
Hydride, copper, 47, 58, 70
of copper, researches on the so-called, 22
Hydriodic and hydrobromic acids, preparation of, 80
Hydrocarbons, distillation of, 209
Hydrocarbo-styril and chinolin, synthesis of the homologues of, 251
Hydrochlorate of ethyl-amin, decomposition of the by heat, 36
Hydrochloric acid, detection of, 176
in a solution of ferric chloride, method of detecting free, 196
physical constants of liquid, 75
Hydro-ferro- and ferri-cyanic acids, action of upon amines, 123
Hydrogen, allotropic conditions of, 80
and ozone, peroxide of, 163, 182
apparatus, sulphuretted, 243
lines, new, 116
nascent, 176, 208, 284
occluded, and atomic weight of aluminium, 285
of water, ammonia from the nitrogen of the atmosphere and the, 155, 195
reduction of metallic oxides by, 92
sulphide, decomposition of mesoxalic acid by, 48
sulphuretted, behaviour with the salts of the heavy metals, 279
Hydrometers, 271

IGASURINE, 77
Iles, M., qualitative separation of copper, bismuth, and cadmium, 263
Ilimow, S. P., qualitative and quantitative determination of albumen in urine, 122
Induction balance, theory of the, 57
coil, effects produced by an, 94
Inorganic substances, melting and boiling-points of certain, 45
Institute of Chemistry, 147, 156
Institution, Royal, 41, 121, 123 235
Interference phenomena in rays of long path, 292
Iodide, reactions of tertiary iso-butylic, 77
Iodine and bromine derivatives of benzin, preparation of the, 58
detection and determination of chlorine in presence of, 280
at elevated temperatures, behaviour of, 151
at high temperatures, density of, 195
in presence of bromine and chlorine, detection and determination of, 110
upon oil of turpentine, action of, 34

Ireland, bog butter from, 205
Irish bog butter, 295
Iron alloys, chromium and tungsten in steel and in, 31
and steel, nitrogen in, 231
application of the pre-existence of Ampère's currents in soft, 58
arseniate, artificial production of a crystalline, 173
dephosphorisation of, 228, 237
ores, &c., separation of silica in limestones, 234
passivity of, 262
proportion of in the mineral waters of Rouen, 262
Isobutyl-aldehyd, action of potassium carbonate upon, 34
Isobutylic iodide, reactions of, 77
Isobutyl-iodide, action of silver cyanate upon, 36
Isomeric dibrom-toluols, six possible, 192
nitramido-and diamido-benzols, products of the sulphurisation of, 219
Isomers of phloro-glucine, 262
Isono, T., "On Shoyu" (review), 282
Isopren, action of hydracids upon, 48
Isopurpurin, flavo-purpurin, and alizarin in mixtures, recognition of, 256

JACKSON, C. L., relative replaceability of bromine in the mono-brom-benzyl bromides, 146
O. R., and A. Baeyer, synthesis of the homologues of hydrocarbo-styril and chinolin, 251
of methyl-ketol, 252
Jacobsen, E., "Acid Rubin," 37
Japp, F. R., action of organo-zinc compounds on quinons, 170
Jay, M., influence of sugars on the determination of urea in urine, 161
Jean, F., sophistication of commercial silicate of soda, 251
Jones, C. H., polysulphides of sodium, 170
F., "Questions on Chemistry" (review), 19
H. C., on a black substance produced from sulphur, 244
H. E., purification of gas, 155
Jorissen, A., chloride of zinc as a reagent for alkaloids, 110
Joulin, L., researches on diffusion, 218
Jüptner, H. v., detection of mercury, 273
Jutsum, S. C., estimation of carbon in iron and steel, 17

KACHLER, J., and F. V. Spitzer, camphen of borneol and of camphor, 252
Kahlbaum, G. W. A., certain mono-chloro-crotonic acids, 173
Kayser, H., influence of temperature upon tuning-forks, 184
Kekulé, A., and H. Schrötter, propyl-bromide into iso-propyl-bromide, 172
Kern, S., some remarks on Siemens Martin steel, 278
steel plates, 178
Kessler, F., alleged non-existence of pentathionic acid, 209
atomic weight of antimony, 107
Kestner, S., digestive ferment produced during panification, 159
Kingzett, C. T., formation of ozone by the atmospheric oxidation of phosphorus, 76
"Nature's Hygiene: a Series of Essays on Popular Scientific Subjects, with Special Reference to the Chemistry of the Eucalyptus and the Pine" (review), 293
Kingzett, C. T., organic matter in water, 254
peroxide of hydrogen and ozone, 182
Kirshwasser, erroneous test for, 230
Kjeldahl, M., action of diastase and pytalin, 160
Knecht, W., and C. Graebe, synthesis of phenyl-naphthyl-carbazol, 146
Koch, A., sulphuretted colouring-matter from para-phenylen-diamin, 81
König, J., quantitative determination of oxygen dissolved in water, 215
Kosmann, Dr., corrosion of metallic zinc when used as boiler protector, 102
Kretschy, M., and L. Barth, researches on picrotoxin, 229
Kuhara, M., method for estimating volumetrically, 153
Kutscheroff, M., oxidation of cholic acid, 172

LADENBURG, A., artificial alkaloids, 159, 220
natural and mydriatic alkaloids of belladonna, datura, jusquiama, 241
on the tropeines, 251
Ladureau, M., utilisation of sewage, 81
Lalieu, M., examination of alkaline dicarbonates, 160
Landolph, F., composition of the anethol derivatives, 251
Langbeck, H. W., cupric test-pellets for sugar, 78
Lapacic acid, 36
Lead, action of concentrated sulphuric acid on, 236
bath, convenient form of, 224
Leaves, physical functions of, 48
Leblanc, R., destruction of burrs in wool, 24
Leeds, A. R., ammonium nitrite, 252
lines of discovery in the history of ozone, 138
nitrous acid in drinking-water, &c., 42
peroxide of hydrogen and ozone, 163
reduction of carbonic acid by phosphorus at common temperatures, 92
solubility of ozone in water, 35
Lefevre, M., megascope and magic lantern, 284
Lefort, J., earthy tritungstates, 24
use of Smithson's battery for the detection of mercury, 79
Legumin, 273
Letellier, A., oxidation of alcohol by the ammoniacal binoxide of copper, 47
"Letts and Co.'s Diaries for 1880" (review), 21
Leuckart, R., acetyl-urea and certain derivatives, 197
Levitzki, M., reducing agents in refining copper and obtaining copper alloys, 272
Levulosate of lime, 92
Lewin, L., decomposition of alkaline tri-sulpho-carbonates in the animal system, 122
Library bindings, deterioration of, 64
Liebmann, A., synthesis of cumol, 219
Light, action of and the function of chlorophyll in plants, 114, 122
Lime, an extremely sensitive reagent for, 102
levulosate of, 92
Lippmann, E. O. v., presence of vanillin in crude sugars, 284
Liquids and gases, motion produced by the diffusion of, 58
constitution of, 284
new method for taking the specific gravity of, 203
Locht, "pantelephone" of, 220
Lockyer, J. N., new method of spectrum observation, 84
Lodge, O. J., intermittent currents and the theory of the induction balance, 57
Loew, O., source of hippuric acid in the urine of the herbivora, 23
Lodis, D. A., on the action of organo-zinc compounds upon nitriles and their analogues, 270
H., sulphur in pyrites, 250
Lovett, W. J., testing vitriol chamber exits, 70, 181
Love, E. G., edible earth from Japan, 187
Lubricants and cements, quantitative determination of fats and resins in, 36
Luminous tubes, new, 58
Lunge, G., action of acid vapours on vegetation, 14
a new phenol reaction, 294
composition of Weldon mud, 78, 129, 141, 179, 181
determination of sulphur in pyrites, 184
nitrous compounds in sulphuric acid, 78
Luckow, C., electric current in analytical chemistry, 213

MACAGNO, H., analyses of air, 97
tannic acid of Sumach leaves, 63
Mach, E., and S. Doubrava, electric perforation of glass, 184
MacIvor, R. W., "Chemistry of Agriculture" (review), 250
Mactear, J., action of concentrated sulphuric acid on lead, 236
manufacture of sulphuric acid, 16, 43, 52, 66
Magenta melt, occurrence of para-leucanilin in the, 146
Magic lantern and megascope, 284
Magnesia, determination of acetyl by means of, 101
Magnesian limestone bricks, 5
Magnesium and aluminium, gases retained by occlusion in, 273
crystalline form of, 282
Magnetic attractions, new experiments on, 241
needles, mutual action of plunged into liquids, 282
Maladies, virulent, 121
Maleic and malic acids from bibrom-propionic acid, 252
and fumaric ether, 172
Mallet, J. W., atomic weight and valence of aluminium, 212
note on the bearing on the atomic weight of aluminium of the fact that the metal occludes hydrogen, 285
Malonic acid, electrolysis of, 183
Maltin and diastase, active matter in, 25
Manchester Literary and Philosophical Society, 204, 248
Manganese and cobalt, determination of, 184
some higher oxides of, and their hydrates, 291
volumetric estimation of, 207
Marchetti, C., certain derivatives of the naphthols, 101
Marignac, C., earths of samarskite, 250
Marriott, W., the frost of December, 1879, 99
Martite of Brazil, 134
Maskelyne, N. S., artificial production of the diamond, 97
supposed artificial production of the diamond, 4
Matter, chemical, stability of in sonorous vibrations, 171
fourth state of, 275
laws which govern, in the spheroidal state, 273
Maumené, E. J., ammonium carbonate, 351
composition of slate, 160
Maxwell, T., para-nitro-phenyl-acetic acid, 35
Mayer, A. M., B. F. Thomas, and H. Morton, electrical measurements of Edison's horse-shoe lamps, 199
Mazzara, G., meta-amido-cinnamic acid, 36
phenol tolylate, 36
Meat, carbonic oxide as an agent for the preservation of, 122
Mechanical equivalent of fat in cattle being fattened, 134
"Medicine, Annals of Chemical" (review), 10, 20
"Medicine, retrospect of" (review), 109
Megascope and magic lantern, 284
Meir, F., and E. Ador, preparation and derivatives of xylylic acid, 80
and J. M. Crafts, density of iodine at hign temperatures, 195
Melting-points of minerals and metals, 279
Mendeleef, D., periodic law of the chemical elements, 2, 27, 39, 49, 61, 71, 83, 93, 106, 113, 125
Menzies, J. W., oxidising value of chlorate and bichromate of potash, 21
Mercurial pump, automatic, 279
Mercury, action of on solution of sodium in ammonia, 133
coloured rings produced on the surface of, 10
detection of, 79, 273
fulminate, explosive properties of, 261
Merz, V., and J. Tibirica, synthetic formation of formic acid, 219
and G. Zetter, some derivatives of resorcin and orcin, 80
Mesoxalic acid, decomposition of by hydrogen sulphide, 48
Meta-amido-cinnamic acid, 36
Meta-chlor-salicylic acid, products obtained by nitrising, 219
Metallic alloys, galvanic conductivity of, 184
arsenic, volatilising-point of, 189
compound, new, 87, 158
nitrates, action of upon monohydrated nitric acid, 23
oxides, reduction of by hydrogen, 92
zinc, corrosion of when used as boiler protector, 102
Metallurgical Chair at the Royal School of Mines, 235
Metals in contact, measurement of the difference of the potential of two, 262
noble, action of ozone on certain, 54
solubility of in petroleum, 284
the electrolytic determination of, 280
Meteorite which fell at Estherville, 262
Meteorological optics, 284
Society, 99, 292
Methylated dioxethylen-amines, 77
products and the preparation of pure methylic alcohol, 220
Methyl-chloride, properties, preparation, and uses of, 281
Methyl-cyanide with common alcohol, certain properties of mixtures of, 218
Methyl-ketol, synthesis of, 252
Methyl-morphine iodide, action of potassium ferricyanide upon, 220
Methylic alcohol, preparation of pure, 220
Metropolitan Water, composition and quality of, 42, 111
Meyer, L., history of atomistic periodicity, 203
V., behaviour of iodine at elevated temperatures, 151

Meyer, V., and H. Züblin, contribution to the knowledge of chlorine, 135
density of bromine vapour at a yellow heat, 151
Michler, W., and F. Salathé, behaviour of sulpho-chlorides with amines, 35
Microphonic apparatus receiving words at a distance, 183
"Mildew and Sizing in Cotton Goods" (review), 9
Milk, analysis of, 230
womens', 102
Milk-sugar, partial synthesis of, 48
Millot, A., reversion of the phosphates in the superphosphates used in agriculture, 160
synthesis of ulmic bodies, 184
Mills, E. J., chemical repulsion, 340
lecture illustration of chemical curves, 191
river water, 260
Mineral acids, detection of in vinegar, 110
lubricating oils, examination of, 25
waters of Rouen, proportion of iron in, 262
Mineralogical Society, 271
Mines, Royal School of, 220, 229, 235
Moissan, H., sulphides and selenides of chrome, 219
Moitessier, M., dissociation of butyl chloral hydrate. 273
and R. Engell, dissociation-tension of chloral hydrate, 70
Molecular weights and specific gravities of substances, 120
Mondesir, P. de, the tensions of saturated vapours have different methods of variation according as they are given off above or below the point of fusion, 212
Monnet, P., F. Reverdin, and E. Noelting, dimethyl-naphthylamin and naphtho-quinon, 209
Mono- and diethylen-diphenyl-diamin, action of nitrous acid upon, 35
Mono-brom benzyl-bromides, relative replaceability of bromine in the, 146
Mono-chloro-crotonic acids, certain, 173
Mono-hydrated nitric acid, action of metallic nitrates upon, 23
Montigny, M., meteorological optics, 284
Morin, H., gelose, 251
Morley, H. F., action of nitrous acid upon mono- and diethylen-diphenyl-diamin, 35
methylated dioxethylen-amines, 77
Morton, H., A. M. Mayer, and B. F. Thomas, electrical measurements of Edison's horse-shoe lamps, 199
Edison's electric light, 182
Mott, H. A, absorption of sugar by bone-black, 287
Mouchot, A., industrial application of solar heat, 295
Mud, composition of Weldon, 78, 129, 141, 179, 181, 219
Muir, M. M. P., chemical equilibrium, 168
essential oil of sage, 223
Mulhouse Industrial Society, 11, 209
Mulvay, J., ozone in nature, its relations, sources, and influences, 292
Muntz and Schlœsing, MM., researches on nitrification, 22
Must and wine, analysis of, 159

NAPHTHALINS, and their Derivatives, Constitution of" (review), 193
Naphthols and azo colouring matters, 283
Naphthols, certain derivatives of the, 101
Naphtho-quinon and dimethyl-naphthylamin, 209
Nascent hydrogen, 284
state, catalytic force and the, 208
"Nature's Hygiene" (review), 193
Mencki, M., and F. Schaffer, chemical composition of the bacteria of putrefaction, 23
Nevile, R. H. C., and A. Winther, six possible isomeric dibromtoluols, 192
Newcastle Chemical Society, 5, 32, 132, 179
"New" methods, 158, 183
Nichols, W. R., deterioration of library bindings, 64
Nickel and cobalt, determination of, 15
researches on, 74
electrolytic determination of, 25
Nickels, B., use of the spectroscope in discriminating anthracenes, 52, 95, 117
Nicotine, new derivatives of, 133
Nietner, H., and K. Zimmermann, carbonic oxide as an agent for preserving meat, 122
Nietzki, Dr. R., retrospect of the progress of the coal-tar industry for the last ten years, 283
toluylen diamin, 123
Nitrates, reduction of during metallic substitutions, 196
Nitric acid, action of on diparatolyl-guanidin, 290
Nitrification, 22
Nitrite, ammonium, 252
Nitrogen, determination of by the Will and Varrentrapp process, 108
determination of in carbon compounds, 223
in iron and steel, 231
of the atmosphere, ammonia from the, and the hydrogen of water, 155, 195
researches on the oxides and acids of, 80
sulphur, &c., detection of in organic bodies, 101
Nitrogenous substances in beetroot, proportion between the sugar and the mineral and, 219
Nitrous acid, action of upon mono- and diethylen-diphenyl-diamin, 35
in drinking-water, &c., 42
Nivet, M., reactions of ammoniacal salts with calcium carbonate, 295
Noelting, E., and F. Reverdin, "Constitutions of the Naphthalins and their Derivatives" (review), 193
P. Monnet, and F. Reverdin, dimethyl-naphthyl-amin and naphtho-quinon, 209
Non-poisonous colours, 282
Norwegium and vesbium, 116

OBALSKI, M., mutual action of magnetic needles plunged into liquids, 282
Octyl derivatives, 36
Ogier, M. J., new hydrate of silicium, 1
Ohl, W., electrolytic determination of cobalt, nickel, and copper, 25
Oil of sage, essential, 223
palm, 146
Turkey-red, 263
Oils, pallet for the assay of, 24
Olein and stearin, quantitative determination of in tallow, 283
Oleo-margarin, detection of in butter, 77
Oligiste from lava of Vesuvius, artificial production of, 36
Olive oil, detection of copper in, 160
Opal and alabaster glass, manufacture of, 160
Optical difference of transparent bodies, method for recognising the, 230
Optics meteorological, 284
Organic bodies, chemical constitution of, 208
containing nitrogen, analysis of, 191
matter in rivers, oxidation of, 246
in water, detection of, 2, 30, 254
solvents, action of upon sulphur and metallic sulphides, 23
Organo-zinc compounds, action of on quinons, 170
upon nitriles and their analogues, 270
Orcin, derivatives of resorcin and, 80
Orcinol derivatives, note on, 286, 290
Ortho-para-toluidin, derivatives of, 251
Ortho-toluidin guanidins, 35
Orthose and quartz, simultaneous reproduction of, 219
Oxalate in plants, signification of calcium, 160
Oxalic acid, crystalline, 219
Oxides and acids of nitrogen, researches on, 80
Oxidising value of chlorate and bichromate of potash, 21
Oxygen dissolved in water, quantitative determination of, 215
Oxygen in barium binoxide, active, 215
Oxygen-stere, 54, with the stere of bromine, chlorine, and agreement of, 263
Oxygenated water, action of upon silver oxide, 183
decomposition of, 159
stability of, 250
Ozone, action of on certain noble metals, 54
formation of by the atmospheric oxidation of phosphorus, 76
in nature, 292
in water, solubility of, 35
lines of discovery in the history of, 138
peroxide of hydrogen and, 163, 182
production of during the combustion of coal-gas, 98

PAINT, luminous, 81, 135
Pallas, M., electricity of cats, 59
Palmelline and characine, 22
preservation of solutions of, 216
Palm oil, 146
Panification, digestive erment produced during, 159
"Pantelephone" of Locht, 220
Papasogli, G., researches on cobalt and nickel, 74
Para- and ortho-toluidin, derivatives of, 251
Para-leucanilin, occurrence of in the magenta melt, 146
Para-nitro-phenyl-acetic acid, 35
Para-phenylen-diamin, sulphuretted colouring-matter from, 81
Para-toluidin, on some products of the oxidation of, 269
"Paris, sewage of" (review), 171, 193
Parsons, H. B., proximate analysis of plants, 256, 267
Pasteur, L., "Studies on Fermentation" (review), 20
virulent maladies, 121
Patent Bill, a new, 285
Paterno, E., and P. Spica, cymen of cuminic alcohol, 36
lapacic acid, 36
Patrouillard, C., determination of thein, 262
Pawel, O., Roussin's salt, 48
Payne, A., new metallic compound, 158
Peaty water, action of air upon, 245
Pechmann, H., constitution of anthraquinon, 52
Peirce, G. K., and E. F. Smith, products obtained by nitrising meta-chlor-salicylic acid, 219
Peligot, E., levulosate of lime, 92
on saccharine, 282
Pellet, H. measurement of the difference of the potential of two metals in contact, 262
existence of ammonia in plants, 241
fixity of the composition of plants: analysis of Soya hispida, 283
proportion between the sugar and the mineral and nitrogenous substances in beetroot, 219
Pellizzari, G., analytical observations on tin, 196
Penke, W. A., and R. Warington on the determination of carbon in soils, 290
Pentathionic acid, 290
alleged non-existence of, 209
Perkin, A. G., on the action of nitric acid on dipara-toluylguanidine, 290
W. H., analysis of organic bodies containing nitrogen, 191
dibrom-anthraquinons, 45
on some products of the oxidation of para-toluidin, 269
and W. Hodgkinson, action of sodium on phenylic acetate, 222
Peroxide of hydrogen and ozone, 163, 182
Perrey, A., potash contained in the clay of arable soils, 70
Perruche, M., new electric burner 48
Perry and Ayrton, Profs., theory of terrestrial magnetism, 91
Persulphuric acid, formation-heat of, 159
studies on, 133
Petroleum Act, 1879, the, 34
and coal benzines, 263
apparatus for testing, 283
report on, 134
solubility of metals in, 284
"Pharmacopœia, United States Revision of the" (review), 294
Pharmacy, South London School of, 10, 197
"Pharmacy, Year-book of" (review), 46
Phenanthren-quinon, behaviour of with ammonia, 203
Phenol glycolicic acid, new method of preparing, 36
poisonous properties of, 24
reaction, new, 294
tolylate, 36
volumetric determination of, 222
Phenols, action of benzoyl-chloride and benzo-trichloride on, 284
Phenyl-aceto-nitrile, action of zinc-ethyl on, 291
Phenyl-betain, preparation of, 122
Phenylic acetate, action of sodium on, 222
Phenyl-naphthalin, synthesis of, 80
Phenyl-naphthyl-carbazol, synthesis of, 146
"Philadelphia College of Pharmacy, Sixteenth Annual Report" (review), 294
Philipp, J., and P. Schwebel, tungsten bronze, 123
Philosophical and Literary Society, Manchester, 204, 243
Society of Birmingham, 131
of Glasgow, 236
Phipson, T. L., catalytic force and the nascent state, 208
palmellin and characin, 22
preservation of solutions of palmellin, 216
reduction of auric chloride, 13
Phloro-glucine, isomers of, 262
Phoneidoscopic process by means of coloured rings, new, 48
Phosphates, action of sulphuric acid upon 220

analysis of, containing silica and fluorine, 101
redonda, 102
reversion of, in the superphosphates used in agriculture, 160
of soluble in ammonium citrate, 173
valuation of reverted, 283
Phosphorescence, phenomena of, 252
Phosphoric acid, blowpipe test for, 187
reverted, valuation of in manurial phosphates, 283
poisoning, variations of urea in cases of, 283
Phosphorus, luminous nature of, 92
products of the slow oxidation of, 73
question, 173
"Photographic Printers' Assistant" (review), 20
Photometer, new chemical, 252
the human eye as an automatic, 179
"Photometer, the Scale" (review), 193
Physical constants of liquid hydrochloric acid, 75
Physical Society, 56, 77, 91, 108, 131, 179, 204, 224, 258, 292
Piccini, A., and M. Fileti, decomposition of the hydrochlorate of ethylamin by heat, 36
Picrotoxin, researches on, 229
Pictet, R., considerations on the experimental possibility of the dissociation of certain non-metallic elements, 284
general equation giving the relation for all liquids between their temperature and the maximum tension of their vapours at this temperature, 273
Pilocarpine, 284
Pinner, A., cyanallyl, 80
Pitkin, L., compound platinates and a new platino-potassium salt, 118
Pittacal and eupittonic acid, 122
Planchud, M. E., formation of sulphuretted mineral waters, 236
Planchon, G., plants which serve as the basis of the different curares, 79
Plant, G., bog butter from Ireland, 205
Plants, fixity of the composition of: analysis of Soya hispida, 283
proximate analysis of, 256, 267
which serve as the basis of the different curares, 79
Platinates, compound, and a new platino-potassium salt, 118
Platinum attacked by melting alkaline carbonates, 25
reduction of gold by hydrogen in presence of, 116
volatility in chlorine gas, 81
Pœhl, A., pilocarpine, 284
Polstorff, K., action of potassium ferricyanide upon methyl-morphine iodide, 220
Porumtaru, M., gelose, 273
Portland cement, 189
Post, Dr. J., composition and analysis of the Weldon mud, 276
J., action of sulphuric acid upon phosphates, 220
composition of Weldon mud, 219
and E. Hardtung, products of the sulphurisation of isomeric nitramido- and diamido benzols, 219
"Potable Water" (review), 283
Potash contained in the clay of arable soils, 70
Potassic bichromate, action of upon acetic acid and potassic-acetate, 36
ferro-oxalate, reducing properties of, 230
Potassium, determination of as platino-potassic chloride, 11
carbonate, action of upon isobutyl-aldehyd, 34
cyanide, action of potassium permanganate upon, 48
ferricyanide, action of upon methyl-morphine iodide, 220
permanganate, action of upon potassium cyanide, 48
decomposition of by oxygenated water, 195
Polymerised non-saturated bodies, 34
Polysulphides of sodium, 170
Pontigga, R., and O. Bayle, new process for bleaching vegetable fibres, 263
"Practical Chemistry: the Principles of Qualitative Analysis" (review), 294
Precht, H., determination of potassium as platino-potassic chloride, 11
Prescott, A. B., "Qualitative Chemistry" (review), 19
Preusse, C., and F. Tiemann, detection of organic matter in water, 30
Prevost, J. H., amount of matter removed from the soil by rain, 44
"Price List of Dr. Theodor Schuchardt's Chemical Works, Goerlitz" (review), 282
Pringsheim, M., action of light and the function of chlorophyll in plants, 115, 122
"Printers', Photographic, Assistant" (review), 20
Procter, H. R., use of the slide rule for chemical calculations, 33
Propyl-bromide, conversion of into isopropyl-bromide, 172
Proteic bodies, products of the splitting-up of, 184
Protochloride of copper, 11
Prud'homme, M., new violet colouring matter, 24
Pump, automatic mercurial, 279
Pumpkins, decomposition of albumen in the sprouts of, 23
Purple of the ancients, 291
Pyrites, determination of sulphur in, 173, 184
sulphur in, 250
Pyroterebic acid, nature of, 209
Pytalin and diastase, action of, 160
researches on, 22

"QUALITATIVE Chemical Analysis" (review), 282
"Qualitative Chemistry" (review), 19
Quartz and orthose, simultaneous reproduction of, 219
Quinic acid, 208
Quinine, 23
salts, 79
separation of from strychnine, 160
Quinon, quinic acid, and connected bodies, studies on, 208
Quinons, action of organ-zinc compounds on, 170

RADENHAUSEN, P., and N. Gerber, analysis of children's food, 101
analysis of milk, 230
womens' milk, 102
Radiograph, the, 204, 292
Rain, amount of matter moved from the soil by, 44
Rammelsberg, C., vesbium and norwegium, 116
Raoult, F. M., coagulation-, oint of alcoholic liquids, 241
Raynaud, M., determination of glycerin in wines, 283
Rease, M., method of detecting free hydrochloric acid in a solution of ferric chloride, 196
Recht, H., volumetric determination of sulphuric acid in sulphates, 24
"Redonda" phosphates, 58, 102
Redwood, B., the Petroleum Act, 1879, 34
Refraction, double, accidental, 146
theory of circular double, 262
Refrigerating mixtures, 295
formed by an acid and a hydrated salt, 283
Regnard, P., chemical composition of the bones in the arthropathy of ataxic cases, 22
Reichel, C., new reaction with gum, 273
Reimer and Harmann, MM., vanillin, 24
Reiset, J., researches on the proportion of carbonic acid in the air, 282
Rénard, A., action of electrolysis upon terebenthen, 172
Rennie, E. H., and C. R. A. Wright, action of benzoyl chloride on morphine, 291
"Report on the Revision of the United States Pharmacopœia" (review), 294
Resorcin and orcin, derivatives of, 80
Reverdin, F., E. Noelting, and P. Monnet, dimethyl-naphthylamin and naphtho-quinon, 209
"Constitutions of the Naphthalins and of their Derivatives" (review), 193
Rhodium alloyed with lead and zinc, action of acids on, 295
Rice, C., "Report on the Revision of the United States Pharmacopœia" (review), 294
Ridout, Mr., amplifying small motions, 292
production of ozone during the combustion of coal-gas, 98
products of the slow oxidation of phosphorus, 73
some effects of vibratory motion in fluids, 108
Riedel, C., and C. Wurster, certain derivatives of dimethyl-meta-toluidin, 35
Righi, A., a case of permanent polarity in steel opposed to that of the magnetising coil by which it is produced, 192
Rivers, oxidation of organic matter in, 246
River water, 143, 260
Rocholl, R., separation of silica in limestones, iron ores, 234
Rœmer, H., and E. Schunck, recognition of alizarin, iso-purpurin, and flavo-purpurin in mixtures, 256
Ross, W. A., "Alphabetical Manual of Blowpipe Analysis" (review), 249
blowpipe analysis, 158
test for phosphoric acid, 187
blue flame in coal fires, 22
Rossetti, M., temperature of the sun, 146
Rössler, C., determination of manganese and cobalt, 184
Rouaix and Dufour, MM., pallet for the assay of oils, 24
Roussin's salt, 48
Rowland, H. A., and G. F. Barker, efficiency of Edison's electric light, 200
Royal Institution, 41, 121, 123, 235
School of Mines, 220, 229, 235
Russell, W. J., Chemical Society, 100
Russian Chemical Society, 160, 173

SACCHARINF, 272
Saccharoses, remarks on, 10
Sage, essential oil of, 233
Saathé, F., and W. Michler, behaviour of sulpho-chlorides with amines, 35
Saline waters, mean composition of, 283
Saligenin, new synthesis of, 58
Salkowski, E. and H., putrefaction products of albumen, 256
Salomon, F., acidimetry of coloured acids, 110
Salt, Boussin's, 48
Samarskite, and gadolinite, new metals from, 72
earths of, 250
Santonin contaminated with strychnine, 283
Sarran, M., experimental researches on the decomposition of certain explosives: composition of the gases formed, 273, 282
"Scale Photometer, the" (review), 193
Schaffer, F., and M. Mencki, chemical composition of the bacteria of putrefaction, 23
Schaffer's glass reaction wheel, 59
Scheibe, A., and C. Wurster, brom-dimethyl-anilin, 35
Schertel, A., melting-points of minerals and metals, 279
Schicht, L., electrolytic determination of metals, 280
Schiff's memoir, reply to, 284
Schlœsing and Muntz, MM., researches on nitrification, 22
Schneider, R., behaviour of arseniferous bismuth with nitric acid, 23
Schröder, H., agreement of the oxygen-stere, 5·4, with the stere of chlorine, bromine, and iodine, 263
Schrötter, H., and A. Kekulé, conversion of propyl-bromide into iso-propyl-bromide, 172
Schuchardt, Dr. T., chemical specimens, 274
"Schuchardt's, Dr., Chemical Works, Price List of" (review), 282
Schulz, H., and C. Binz, chemical cause of the poisonous character of arsenic, 122
Schulze, E., and J. Barbieri, decomposition of albumen in the sprouts of pumpkins, 23
Schunck, E., notes on the purple of the ancients, 291
and H. Rœmer, recognition of alizarin, iso-purpurin, and flavo-purpurin in mixtures, 256
Schwebel, P., and J. Philipp, tungsten bronze, 123
Science, Yorkshire College of, 197
Sciences, the Academy of, 92
Scientific researches, report on, of members of learned societies, 284
Seelheim, F., volatility of platinum in chlorine gas, 81
Selenides and sulphides of chrome, 219
Sendtner, R., and C. Wurster, dimethyl-para-phenylen-diamin, 35
"Sewage of Paris" (review), 171
193
Sewage purification, 284
town, infection with, 184
treatment of, 50, 73
utilisation of, 81
Shenstone, W. A., igasurine, 77
Shettle, Dr., influence of solar radiation on the earth's rotation, 292
"Shoyu" (review), 282
Siemens-Martin steel, remarks on, 278
Silica and fluorine, analyses of phosphates containing, 101
in limestone, iron ores, &c., separation of, 234
Silicate of soda, sophistication of, 251
Silicium, new hydrate of, 1
Silicon and boron fluorides, action of water on, 134
Silico-titanates, sodium, two new, 241
silver cyanate, action of upon isobutyl iodide, 36
determination of in galena, 42

Silver tetroxide, 195
Sizing of cotton goods, 34
" Sizing of Cotton Goods " (review), 9
Skatol, 80
Skraup, Z. H., quinin, 23
Slate, composition of, 160
Smith A., treatment of sewage, 50
A. P., blue flame in coal-fires, 47
sulphuretted hydrogen apparatus, 243
E. F. A., new base, 219
and G. R. Peirce, products obtained by nitrising meta-chlor-salicylic acid, 219
J. L., meteorite which fell May 10, 1879, at Estherville, 262
report on petroleum, 134
R. A., measurement of the actinism of the sun's rays, 211
W., analyses of the ash of Eucalyptus wood, 248
convenient form of lead-bath, 224
synthesis of phenyl-naphthalin, 80
and T. Takamatsu, penta-thionic acid, 290
Society of Arts, 59, 87, 134, 225, 295
of Industrial Chemists, proposed, 243, 260
Society of Public Analysts, 46
Soda ash, valuation of, 161, 173, 185
Leblanc, and ammonia, 102
sophistication of silicate of, 251
Sodium, action of on phenylic acetate, 222
silico-titanites, two new, 241
trichlor-acetate, dry distillation of, 35
" Soils and Manures, Coffee, Ceylon " (review), 217
Soils, determination of carbon in, 290
Solar heat, industrial application of, 295
radiation, influence on the earth's rotation, 292
spectrum, photography of the, 195
Solids in gases, solubility of, 103, 133
vacuo, volatilisation of, 191
Solubility, notes on, 165
Sommaruga, E., behaviour of phenanthren-quinon with ammonia, 203
Sommerkorn, H., new method for taking the specific gravity of liquids, 203
South London School of Pharmacy, 197
Soya hispida, analysis of, 283
Specific gravities and molecular weights of substances, 120
gravity, new instrument for deter nination of, 154
of liquids, new method for taking, 203
tables of, 295
Spectral analysis, contributions to quantitative, 230
Spectroscope, slit for, 79
use of the in discriminating anthracenes, 52, 95, 117
Spectroscopic notes, 172
Spectrum observation, new method of, 84
Spence's metal, 272
Spica, P., detection of nitrogen, sulphur, &c., in organic bodies, 101
and E. Paterno, cymen of cuminic alcohol, 36
Spitzer, F. V., and J. Kachler, camphen of borneol and of camphor, 252
Spottiswoode, W. E., effects produced by an induction-coil, 94
Staats, G., derivatives of ortho- and para-toluidin, 251
Stannous chloride, vapour-density of, 35
Starch, history of, 22
Stearin and olein, quantitative determination of in tallow, 283
Stebbins, J. H., certain azo-compounds, 219
some new azo-colours, 117
Steel and electricity, 81
and iron, nitrogen in, 231
changes in the specific gravity of, 70
estimation of carbon in, 17, 152, 229, 250
opposed to that of the magnetising coil by which it is produced, a case of permanent polarity in, 192
plates, note on, 178
Siemens-Martin, remarks on, 278
Stenhouse, J., and C. E Groves, betorcinol and some of its derivatives, 168, 175
on gardenin, 252
preliminary note on some orcinol derivatives, 286, 290
Stokes, the law of, 184
Stolba, F., crystalline calcium fluoride, 24
volumetric determination of cerium, 31
Stones, artificial production of precious, 68
Strasburg, Chemical Institute of the University of, 208
Strychnin, santonin contaminated with, 283
separation of quinin from, 160
Stürtz, B., phenomena of phosphorescence, 252
Sugar, absorption of by bone-black, 287
action of bone solutions of pure, 66
and the mineral and nitrogenous substances in beet-root, proportion between the, 219
cupric test-pellets for, 63, 78, 91
starch, mixed with cane-sugar, detection of, 221
Sugars, crude, presence of vanillin in, 284
Sulphates, alkalimetric, determination of, 114, 158
Sulphides and selenides of chrome, 219
Sulpho-chlorides, behaviour of with amines, 35
Sulphur and metallic sulphides, action of organic solvents upon, 23
an experiment on, 110
condition in which it exists in coal, 201
in pyrites, 250
determination of, 173, 184
nitrogen, &c., detection of in organic bodies, 101
on a black substance produced from, 244
Sulphuretted colouring-matter from para-phenylen-diamin, 81
hydrogen apparatus, 243
behaviour of with the salts of the heavy metals, 279
mineral waters, formation of, 236
Sulphuric acid, action of upon phosphates, 220
comparison of the apparatus for the concentration of according to the systems of Delplace and Prentice, 274
concentrated, action of on lead, 236
in sulphates, volumetric determination of, 24
manufacture of, 16, 43, 47, 52, 67, 78, 263
Sumach leaves, tannic acid of, 63
Sun's rays, measurement of the actinism of the, 211
Sun, temperature of the, 146
Superfusion, on the influence of on the molecular arrangement of cupelled gold, 266
Superphosphates used in agriculture, reversion of the phosphates in the, 160
Swan, Mr., smoke of an electric lamp, 32
Synthesis of aromatic aldehyds, 172

TAKAMATSU, T., and W. Smith, on pentathionic acid, 290
Tanatar, S., bioxy-fumaric acid, 172
maleic and malic acids from bi-brom-propionic acid, 252
Tannic acid of sumach leaves, 63
Tar, certain constituents of, 80
distillers v. gas companies, 289
" Tar-colour Works of Messrs. Meister, Lucius, and Brüning " (review), 216
Tattersall, T., notes on the alkaloids, 63
Technical society, proposed, 243, 261
Technological pictures from western England, 109
Technology of the Mint, 234
Teed, F. L., on a simple method of determining vapour-densities in the barometer vacuum, 271
Telegraph, aluminium wires for the, 134
Telephonic circuits, induction in, 56
Temperatures, determination of high, 218
Terebenthen, action of electrolysis upon, 172
Teroxide, silver, 195
Terpenes, examination of for cymene, 291
Terrestrial magnetism, theory of, 91
Tetra-methyl-ammonium nitrate, formation of, 241
Thalheim, W., formation of graphite by the decomposition of cyanogen compounds, 283
Thein, determination of, 262
Thermic laws of electric sparks, 70, 195
Thermo-chemical researches, 80, 197
Thermograph, a new, 293
Thibaut, M., variations of urea in cases of phosphoric poisoning, 283
Thomas, B. F., H. Morton, and A. M. Mayer, electrical measurements of Edison's horse-shoe lamp, 199
Thompson, J. B., ammonia from the nitrogen of the atmosphere, 240, 272
Thomsen, J., allotropic conditions of hydrogen, 80
formation-heat of cuprous chloride, 251
of cyanogen, 251
researches on the oxides and acids of nitrogen, 80
thermo-chemical researches on the carbonates, 80, 197
Thomson's galvanometer, 63
Thomson, W., " Sizing of Cotton Goods " (review), 9
Thorpe, Prof., molecular weights and specific gravities of substances, 120
Thudichum, J. L. W., " Annals of Chemical Medicine " (review), 10, 20
Tibirica, J., and V. Merz, synthetic formation of formic acid, 219
Tidy, C. M., composition and quality of the Metropolitan water, 42, 111
river water, 143
water analysis, 272
Tidy's paper on river water, observations on, 265
Tiemann, F., and C. Preusse, detection of organic matter in water, 30
Tilden, W. A., " Practical Chemistry : the Principles of Qualitative Analysis " (review), 294
Time in Paris, electric regulation of, 195
Tin, analytical observations on, 196
and lead in dilute acetic acid, solubility of alloys of, 109
Tôkio, contributions from the laboratory of, 76
Toluylen-diamins, 123
Tolylate, phenol, 36
Tommasi battery, application of the, 58
Dr., nascent hydrogen, 176, 284
new and old views on the nascent state of bodies, 1
reduction of gold by hydrogen in the presence of platinum, 116
reply to Prof. Ugo Schiff's memoir on certain observations made in a former paper of the author's, entitled "Researches on the Constitutional Formulæ of the ferric compounds, 284
Universal Electrical Company, 252
Tompkins, H. K., and E. Frankland, action of zinc-ethyl on phenyl-aceto-nitrile, 291
Toxicology, review of, 209
Tresca, M., electric regulation of time in Paris, 195
Trève, M., application of the pre-existence of Ampère's currents in soft iron, 58
new luminous tubes, 58
Trichinosis, 37
Trichlor-acetate, dry distillation of sodium, 35
Trisulpho-carbonates in the animal system, decomposition of alkaline, 122
Tritungstates, earthy, 24
Troost, L., and H. Ste.-Claire Deville, determination of high temperatures, 218
Tropeines, on the, 251
Tucker, A. E., slit for spectroscope, 79
Tungsten and chromium in steel and in iron alloys, 31
bronze, 123
Tuning forks, influence of temperature upon, 184
Turkey-red oil, 263
Turpentine, action of iodine upon oil of, 34

ULBRICHT, R., analysis of wine and must, 159
Ulmic bodies, synthesis of, 184
Ultramarine, 284
compounds, 23
Urea, determination of by means of alkaline hypochlorites and hypobromites, 161
palladious chloride, 23
variations of in cases of phosphoric poisoning, 283
Urech, F., action of potassium carbonate upon isobutyl-aldehyd, 34
Urine, influence of sugars on the determination of urea in, 161
qualitative and quantitative determination of aloumen in, 122
Urquhart, J. W., " Electro-plating " (review), 19

VALENTIN, the late W. G., " A Course of Qualitative Chemical Analysis " (review), 282
Vanadiates, new property of the, 218
Van der Ploeg, B. J., signification of calcium oxalate in plants, 160
Van Dorp, W. A., and S. Hoogewerff, carbon acids of pyridin, 220
Van Riemsdijk, Dr. A. D., on the influence of superfusion on the molecular arrangement of cupelled gold, 266
phenomenon of flashing in assays of gold, 126

Vanillin, 24
presence of in crude sugars, 284
Vapour-densities, simple method of determining in the barometer vacuum, 271
Vapour-density determinations, error in, 260
Vapours, saturated, the tensions of, have different methods of variation, according as they are given off above or below the point of fusion, 282
temperature of the decomposition of, 22
Varenne, L., passivity of iron, 262
Vasey, T. E., testing of vitriol-chamber exits, 47, 91, 145
Vegetable fibres mixed with wool, destruction of, 37
new process for bleaching, 263
Veley, V. H., on some higher oxides of manganese and their hydrates, 291
Verneuil, A., and L. Bourgeois, artificial production of a crystalline iron arseniate, 173
Vernon, A., review of toxicology, 209
Vesbium and Norwegium, 116
Vesuvius, artificial production of oligiste from the lava of, 36
Vieille, M., experimental researches on the decomposition of certain explosives: composition of the gases formed, 273, 282
and M. Berthelot, explosive properties of mercury fulminate, 261
Villari, E., thermic laws of electric sparks, 70, 195
Villiers, A., crystalline oxalic acid, 219
Vincent, C.M., reactions produced by aqueous dimethylamin upon metallic solutions, 173
and M. Delachanal, certain properties of mixtures of methyl-cyanide with common alcohol and methylic alcohol, 218
Violet colouring matter, new, 24
Vision, phenomena of, 146
Vitriol chamber exits, testing of, 47, 69, 70, 91, 145, 146, 181, 188
Vogel, A., proportion of water in alcohol, 36
H. W., new hydrogen lines, 116
spectroscopic notes, 172
Volta, A., action of ozone on certain noble metals, 54
Voltaic condenser, 84
Von Morden, C., contributions to quantitative spectral analysis, 230
Vortmann, G., detection and determination of chlorine in presence of bromine and iodine, 280

WAGNER, G., arsenic in water colours, 110
Wallace, W., condition in which sulphur exists in coal, 201
"Glasgow Sewage" (review), 207
heating power of coal-gas, 41
Warington, R., observations upon Dr. Tidy's paper on river water, 265
and W. A. Peake, determination of carbon in soils, 290
Wartha, V., explosion during the heating of wine, 262
Water, action of on silicon and boron, 134
analysis, 272
"Water Analysis for Sanitary Purposes" (review), 206
Water, detection of organic matter in, 30
Metropolitan, composition and quality of, 42, 111
of Carisbrooke Castle well, 10, 57
organic matter in, 254
oxygenated, stability of, 250
peaty, action of air upon, 245
preparation of free from ammonia, 160
proportion of in alcohol, 36
quantitative determination of oxygen dissolved in, 215
Water, river, 143, 260
observation on Dr. Tidy's paper on, 265
solubility of ozone in, 35
Waters, Dublin, examination of some, 62
mineral, formation of sulphuretted, 236
Watson, Mr., Portland cement, 189
Weber, F. H., theory of Fresnel's interference phenomena, 184
Werdermann, Prof., phenomena of interference in rays of long path, 292
Weidel, H., and G. L. Ciamician, carbons obtained from animal tar, 220
and J. Herzig, compounds from animal tar, 122
Weldon mud, composition of, 78, 129, 141, 179, 181, 219
and analysis of, 276
W., volumetric estimation of manganese, 207
Westmoreland, J. W., estimation of carbon in steel, 152, 250
Whewell, G., sizing of cotton goods, 34
Whitlam, W. G., Spence's metal, 272
Wiebe, H. F., absolute expansion of liquid and solid bodies, 35
Wigner, G. W., water of Carisbrooke Castle well, 10
Will and Varrentrapp's process, determination by the, 108
Williams, C. T., the winter climate of Danos, 292
W. C., and T. Carnelly' melting- and boiling-points of certain inorganic substances, 45
Wiley, H. W., detection of hydrochloric acid, 176
Wilm, T., determination of chromium, 222
Wine and must, analysis of, 159
detection of foreign colouring matters in, 269
explosion during the heating of, 262
manufacture in Hungary, 110
unfermented, sale of, 56, 70
Wines, determination of glycerin in, 273
Winstanley, D., the radiograph, 204, 292
Winther, A., and R. H. C. Nevile, six possible isomeric dibromtoluols, 192
Wolff, C. H., new colorimeter, 109
Wood, W. H., action of mercury on solution of sodium in ammonia, 133
Wool, destruction of burrs in, 24
destruction of vegetable fibres mixed with, 37
Wright, C. R. A., and E. H. Rennie, action of benzoyl chloride on morphine, 291
wright, C. W., chemical affinity in terms of electromotive force, 108
L. T., products of combustion of coal-gas, 169
Wurster, C., and C. Riedel, certain derivatives of dimethyl-meta-toluidin, 35
and R. Sendtner, dimethyl-para-phenylen-diamin, 35
and A. Scheibe, brom-dimethyl-anilin, 35
Wurtz, A., chloral hydrate, 79
combination-heat of chloral hydrate, 159
hydride of copper, 58
temperature of the decomposition of vapours, 22

XYLYLIC acid, preparation and derivatives of, 80

"YEAR-BOOK of Pharmacy (review), 46
Yellow heat, density of bromine vapour at a, 151
Yorkshire College of Science, 197

ZETTER, G., and V. Merz, some derivatives of resorcin and orcin, 80
Zimmermann, J., preparation of phenyl-betain, 122
K., and H. Nietner, carbonic oxide as an agent for the preservation of meat, 122
Zinc-ethyl, action of on azobenzene, 270
action of upon benzo-nitrile, 270
upon phenyl-aceto-nitrile, 291
Zinc, note on the actual state of the determination of, 279
ores of, influence of air in the reduction of the, 220
Zinc-powder, new method of determining the value of, 161
Zinc, separation and estimation of cadmium in, 28
separation of gold by quartation with, 173
Züblin, H., and V. Meyer, contribution to the knowledge of chlorine, 135
density of bromine vapour at a yellow heat, 151

END OF VOLUME XLI.

THE

CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE.

WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE."

A Journal of Practical Chemistry

IN ALL ITS APPLICATIONS TO

PHARMACY, ARTS, AND MANUFACTURES.

EDITED BY

WILLIAM CROOKES, F.R.S., &c.

VOLUME XLII.—1880.

LONDON:
PUBLISHED AT THE OFFICE, BOY COURT, LUDGATE HILL, E.C.
AND SOLD BY ALL BOOKSELLERS.

MDCCCLXXX.

LONDON

PRINTED BY EDWIN JOHN DAVEY

BOY COURT, LUDGATE HILL, E.C.

THE CHEMICAL NEWS,

VOLUME XLII.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1075.—JULY 2, 1880.

ON THE LOWERING OF THE FREEZING-POINT OF WATER BY PRESSURE.*

By JAMES DEWAR, M.A., F.R.S.,
Jacksonian Professor of Natural Experimental Philosophy in the University of Cambridge.

THE Cailletet pump may be conveniently employed to observe the thermal effects of compression on solid and fluid substances. Before engaging in an investigation on this subject, it was necessary to test the apparatus, and especially the manometer. For this purpose it seemed, on theoretical grounds, that observations on the lowering of the freezing-point of water by pressure would be a severe test of the accuracy of the pressure gauge, and the constancy of the records of thermo-junctions under pressure. I am not aware of any quantitative experiments on this subject having been made under high pressures. Sir William Thomson carried the proof of the accuracy of Professor James Thomson's great theoretical discovery to a pressure of 17 atmospheres.† The experiments of Mousson (*Pogg. Annalen*, 1858) were not of a quantitative character, being merely intended to show that ice at a temperature of −18° C. might still be liquefied by the application of an enormous pressure. The following experiments appear to show that a convenient manometer for very high pressures, based on the observations of the freezing-point, may be easily constructed.

In all the following experiments the galvanometer, moving to the negative side, showed a cooling effect of the junction inside the bottle. One division on the arbitrary scale represented $\frac{1}{1\frac{1}{2}}$ of a degree C. Two thermo-junctions were used, made of iron-copper wires, which were insulated by a covering of marine glue, the junctions themselves being covered with a thin layer of gutta-percha dissolved in benzol.

One junction was placed in the bottle, to show the effect of pressure under different circumstances, the other being kept outside at the constant temperature of melting ice.

Series I.

One junction, which was fixed in a brass flange with marine glue, frozen in a test-tube containing boiled water, was placed in the iron bottle and surrounded with water at 0° C., the bottle itself being packed round with ice.

The pressure was increased by 25 atmospheres at a time. The galvanometer showed a deflection immediately the pressure was applied, rapidly coming to rest at the new position, and it remained perfectly steady as long as the pressure was maintained.

The following is one of many series of experiments, which agreed very nearly. Pressures were recorded by a metallic manometer which had been checked on several occasions. The records of the first 25 atmospheres pressure are not reliable.

Galvanometer zero + 1.

				Increase.
25	atmospheres = −	26	position on scale	
50	,, = −	43	,, ,,	17
75	,, = −	62	,, ,,	19
100	,, = −	82	,, ,,	20
125	,, = −	100	,, ,,	18
150	,, = −	120	,, ,,	20
175	,, = −	142	,, ,,	22
200	,, = −	163	,, ,,	21
225	,, = −	185	,, ,,	22
250	,, = −	203	,, ,,	18
275	,, = −	223	,, ,,	20
300	,, = −	243	,, ,,	20

This represents a mean deflection of 19·7 on the scale, being 0·18 of a degree C. for 25 atmosperes, or a lowering of the freezing-point by 2·1° C. for the total range of pressure. The mean reduction for one atmosphere pressure is 0·0072°.

These experiments were afterwards repeated, with a stronger pump, to 700 atmospheres. Exactly the same mean deflection was observed, and the galvanometer moved with the same regularity.

Series II.

The junction in the flange was placed in a piece of quill tubing, open at top and bottom, in order to insulate it from the sides of the iron bottle, and surrounded with water at 0° C. instead of ice, the iron bottle being afterwards packed, as before, in ice, and the other junction being outside in ice and water.

This showed a very slight decrease of temperature on applying pressure, the whole deflection for 200 atmospheres being only about 4 divisions, or $\frac{1}{3}\frac{1}{5}$ of a degree C. This agrees with Joule's experiments on the compression of water.

Series III.

A mixture of finely powdered ice and water was placed round the junction inside the bottle, which was as usual,

* A Paper read before the Royal Society June 17, 1880.

† "The Effect of Pressure in Lowering the Freezing-Point of Water experimentally demonstrated." *Phil. Mag.*, 1850.

packed afterwards in ice. It will be seen, from the following set of readings, that the deflection was about the same as when the junction was frozed into a block of ice, the only difference being that whereas the galvanometer in the first series assumed its new position immediately the pressure was applied, the instrument now required from two to three minutes before coming finally to rest, the action being far more sluggish.

Zero = +6.

Pressure.	Position on Scale.	Difference.
25	− 17	
		19
50	− 36	
		19
75	− 55	
		19
100	− 74	
		17
125	− 91	
		19
150	−110	
		20
175	−130	
		19
200	−149	

Mean deflection for 25 atmospheres is 19·4 divisions of the scale.

Series IV.

Brine was placed round the junction in the bottle, the latter being afterwards packed in ice and salt, to reduce the temperature of the brine to −20° C., the other junction being placed in ice and salt on the outside. The junctions were then connected up with the galvanometer, and allowed to remain untill the temperatures became equalised:—

Zero+85.

Atmospheres.	Position on Scale.	Increase.
25	+ 98	
		8
50	+106	
		9
75	+115	
		6
100	+121	
		7
125	+128	
		6
150	+134	
		4
175	+138	
		4
200	+142	

In this case a heating effect was produced, which seemed, however, to decrease as the pressure was increased. It represents an increase of $\frac{1}{25}$ of a degree C. for the whole 200 atmospheres.

Series V.

The junction in the flange was frozen into a solid block of ice, and placed in a bottle, surrounded with brine at −20° C., the bottle being packed in ice and salt. A very slight heating effect was produced, which only amounted to about 1½ divisions for 200 atmospheres.

Series VI.

These experiments were made with the junction frozen into a test-tube with water, and placed in the bottle with mercury surrounding it instead of water. This gave exactly the same deflection of the galvanometer as when water was employed, only the experiment could not be carried on for a long time, as the ice melted with considerable rapidity, from the heating of the mercury by compression.

Series VII.

As in several cases the junction that was placed inside the bottle, and which had been several times subjected to high pressures, appeared to be affected by the compression and worked somewhat irregularly, it was thought advisable to subject both the junctions to the same compression, so as to have them both under the same conditions. For this purpose both junctions were passed through the brass flange, being well insulated by marine glue, the one remaining on the outside of the test-tube in which the other was frozen.

The results with ice were exactly the same as when one junction was placed outside the bottle, but pressure still appeared to have an effect upon the junctions, as after one or two series of compression experiments they could be no longer relied upon, and worked very irregularly. The only way to obviate this difficulty was, therefore, to prevent the junctions being submitted to pressure at all, and this was effected by soldering a stout iron tube, about ¼ inch internal diameter, into the brass flange, which reached to about the centre of the bottle. The tube was closed at the bottom and contained a few c.c. of alcohol, into which the junction was lowered from the outside. The part of the tube which went into the bottle was then frozen into the test-tube with water, and thus sustained all the pressure while the alteration of temperature was conveyed through the iron to the junction.

This worked exceedingly well, giving exactly the same results as before, the only drawback being that the action was very sluggish, the galvanometer taking about two minutes to come to rest after each addition of pressure. The above results seem to prove that the calculated value of the variation of the freezing-point of water, deduced from the observed difference of volume of ice and water, and the latent heat of fluidity at the melting-point under one atmosphere of pressure, is identical with the mean experimental value obtained from a series of observations extending to 700 atmospheres. From Clapeyron's formula we are thus entitled to infer that $\frac{TV}{L}$ = constant, where T is absolute temperature, V is difference of volume, and L is latent heat of fluidity. If V is assumed to be approximately constant, then T and L thus is the latent heat of ice, diminished as the freezing-point is lowered by pressure. This is in accordance with the deductions of Clausius* from other considerations.

THE ALUMINIUM-IODINE REACTION.†

By J. H. GLADSTONE, Ph.D., F.R.S., and ALFRED TRIBE, F.C.S., Lecturer on Chemistry in Dulwich College.

ABOUT four years ago we pointed out a reaction of iodide of aluminium which, as far as we are aware, has no precise analogue in the science of chemistry, and which has led to the discovery of several volatile aluminium alcohols. It is well known that neither water, alcohol, nor ether is decomposed by metallic aluminium, and that each of these bodies will dissolve iodine without entering further into combination with it; but we found that by the joint action of these two elements, it was possible to split up the above-mentioned liquids. Water, though forming a definite hydrate with the iodide of aluminium, is decomposed by it in the presence of an excess of the metal, hydrogen being evolved and aluminic hydrate formed. This takes place at the ordinary temperature.

Alcohol in a similar manner is decomposed by the joint action of metallic aluminium and its iodide, with the ultimate production of hydrogen gas, aluminic ethylate, and varying amounts of aluminic iodoethylate proportional to the quantity of aluminic iodide employed. A small quantity of the iodide suffices to bring about the formation of a very large amount of the ethylate; in fact, the process would be a continuous one, were it not that the solid products gradually put a stop to the reaction.

Ether is not affected by aluminic iodide and aluminium, but when exposed to iodine and aluminium simultaneously it suffers a violent decomposition, iodide of ethyl and the aluminic iodoethylate being the ultimate products.

Amylic ether behaves in a similar manner, and the acetates of ethyl and amyl give analogous results; but the reaction is not an ordinary double decomposition, for it

* *Phil. Mag.*, 1851.

† A Paper read before the Royal Society, June 17, 1880.

does not take place when ready formed iodide of aluminium is employed.

The several changes thus described are typical of our "aluminium-iodine reaction." The reaction is quite distinct from that which has lately given beautiful results in the hands of Friedel; and we have investigated its applicability both for the production of new compounds, and for distinguishing between different classes of organic bodies, as well as for throwing light on their comparative constitution.

Neither zinc nor iron, nor, as far as we know, any other metal can be substituted for aluminium in this reaction; but the chloride or bromide may be used instead of the iodide, though with less advantage.

Recent Results.

For decomposing an alcohol a small quantity of iodine is dissolved in it, the necessary excess of aluminium is added, and the mixture is heated. Evolution of hydrogen gas begins immediately, and proceeds somewhat rapidly until the whole of the metal has passed into combination. In this way the aluminium derivaties of the following alcohols have been prepared:—Ethylic, normal propylic, iso-butylic, amylic, benzylic, phenylic, cresylic, and thymolic. The first four of these aluminium derivatives may be distilled *in vacuo*, and they have thus been separated from the other solid products of the reaction, and obtained in a pure condition. The other aluminic alcohols cannot be distilled, at any rate not without very considerable decomposition. The following alcohols, however, behave in a different way with the reagent:—

Methyl alcohol is not decomposed by aluminic iodide and aluminium, but in presence of free iodine it parts slowly with hydrogen, and the same happens when an aluminium-platinum couple is substituted for the metallic aluminium.

Iso-propyl alcohol.—This is not acted upon in the least by the reagents.

Cetyl alcohol.—On heating this compound with the reagent, hydrogen is slowly set free, untill the temperature reaches about 200° C., when another chemical change is set up, resulting in the formation of cetyl iodide and aluminic hydrate.

Allylic alcohol.—The first action is identical in character with that which takes place with the alcohols of the $C_nH_{2n+1}OH$ series. Instead, however, of the whole of the liberated hydrogen escaping, about 30 per cent of it acts upon the excess of alcohol, splitting it up into propylen and water.

Ethene alcohol.—The reagent does not liberate hydrogen from this substance, and has but a very slight action upon it.

Propenyl alcohol.—No hydrogen is evolved, but a double decomposition ensues at about 140° C., yielding allyl iodide, free iodine, and aluminium hydrate; if aluminium be in excess, aluminic hydrate and allylic iodide are the sole products.

Aldehyd.—Hydrogen is not set free from this compound.

The general result, then, of these observations is that the reagent substitutes aluminium for the basic hydrogen of water, and of all the alcohols hitherto tried, whether of the methyl, allyl, benzyl, or phenyl series, with remarkable exception of iso-propyl alcohol. On the other hand, it does not substitute aluminium for hydrogen in the dihydric or trihydric alcohols, nor yet with aldehyd. The reaction with the ethers and glycerin is of a different character, as, in addition to an aluminium compound, the iodides of the positive radicals are formed.

General Properties of the Aluminium Alcohols.

The aluminium alcohols are solid at the ordinary temperature, and fuse generally into clear liquids. They possess, in a marked degree, the property of remaining fluid far below their melting-points. Those of the methyl series distil unchanged at reduced pressures, affording the first organic compounds which contain both oxygen and a metal and are capable of distillation. They are soluble more or less in ether, alcohol, and benzol, but are decomposed by water with the formation of aluminium hydrate and the alcohols. They were found to have the following specific gravities at 4° C.:—

Ethylate	1·147
Propylate	1·026
Butylate	0·982
Amylate	0·980
Phenylate	1·25
Cresylate	1·166
Thymolate	1·04

Action of Heat.—All these alcohols are decomposed at a temperature somewhere about their boiling-points, and it became an interesting subject of inquiry whether they were resolved into alumina, and the alcohol and its olefine, or into alumina and the ether. Both these actions seem to take place. Thus aluminic ethylate appears to be decomposed by heat in both ways, but mainly according to the following scheme:—

$$(C_2H_5O)_6Al_2 = Al_2O_3 = 3C_2H_4 + 3C_2H_6O.$$

Aluminic phenylate, on the other hand, is capable of decomposition mainly in the following way:—

$$(C_6H_5O)_6Al_2 = Al_2O + 3(C_6H_5)_2O.$$

It must not, however, be supposed that these decompositions take place without other reactions. Some of the bodies thus produced are new ones, and we are at present engaged in their investigation.

The most interesting decomposition is that of the thymolate. When heated it splits up into alumina, propylene, and bodies of the cresylic group. One of these is a solid body, which, when re-sublimed or crystallised from alcohol, presents itself in most beautiful pearly plates. Its properties resemble rather those of an ether, and concordant analyses of different specimens and determinations of vapour density give the anomalous molecular formula $C_{14}H_{13}O$, but its real constitution is still the subject of inquiry.

Theory of Reaction.

The reaction by which the compounds described above are formed is by no means clear at first sight. It is difficult to imagine that the presence of a haloid salt should determine the direct replacement of hydrogen by aluminium in water or in alcohol. We believe, however, that the presence of hydriodic acid in the reaction with the aromatic alcohols furnishes the true key to the chemical change. The first action is in all probability that of a reciprocal decomposition between two binary compounds, the alcohol and aluminium iodide,—forming a certain proportion of aluminium alcohol and hydriodic acid. But the metallic aluminium present at the same time decomposes the hydracid with evolution of hydrogen and the production of more aluminium iodide, which brings about a further redistribution of the elements and the formation of more of the aluminium alcohol and the hydriodic acid, and so on till the chemical change is complete. The following equations express these changes, which take place alternately, or rather continuously:—

(1.) $6(C_nH_{2n-7}O.H)Al_2I_6 = Al_2(C_nH_{2n-7}O)_6 + 6HI.$

(2.) $6HI + Al_2 = Al_2I_6 + 6H.$

It is evident that, as the iodine does not enter into the final products, a very small quantity of it is sufficient to carry on the continuous chemical change.

There can be little doubt that the same reactions occur in the case of the alcohols of the $C_nH_{2n+1}O.H$ series, but the amount of hydriodic acid formed in the reciprocal decomposition is perhaps very small, and the tenacity with which it is held by the alcohol has made it impossible for us to prove its separate existence. The same remark applies also to water, which we believe to act in the same way. Indeed we know, from the experiments of Roscoe,

that there would be no chance of separating minute quantities of acid from an aqueous solution under the circumstances.

The part which the free elements take in the decomposition of the ethers is doubtless analogous to that which the combined elements play in the action with water and alcohol. The reason why the free elements do, and aluminic iodide does not, attack the ethers, is probably owing to the available energy being greater in the former than in the latter case.

In conclusion, we would commend this aluminium-iodine reaction to the consideration of other chemists who may be investigating organic compounds containing oxygen.

ON VIRULENT DISEASES, AND ESPECIALLY ON THE DISEASE COMMONLY CALLED CHICKEN CHOLERA.*

By M. PASTEUR.

Virulent diseases may be ranked among the greatest of the evils that afflict living beings. To prove this, we have merely to name measles, scarlatina, variola, syphilis, glanders, the carbuncular disease, yellow fever, typhus, and the cattle plague. This list is far from being complete; the pathology of the most important diseases may find a place here.

When the ideas of Liebig on the nature of ferments were in vogue, each virus was considered as a substance undergoing an internal change, which could be communicated to living organisms, turning the constituents of these into a virus of the same nature. Liebig was well aware that the first apparition of the ferments, their multiplication and their power of decomposition, present the greatest analogies with the phenomena of life, but, in the introduction to his "Organic Chemistry," he tells us that these analogies may be considered as deceitful illusions.

All the experiments which I have communicated to this Academy for the last twenty-three years have demonstrated, either directly or indirectly, the inaccuracy of the opinions of Liebig. A single method has guided me in the study of microscopic organisms. This method has been essentially the cultivation of these minute beings in a pure state; that is, by eliminating the heterogeneous substances, living or dead, which accompany them. By the use of this method, the most difficult questions are often solved in the easiest and most decisive manner. I will here recall one of the first applications which I made of this method (1857-1858).

Ferments, according to Liebig, are the nitrogenous substances of organisms, such as fibrine, albumen, casein, &c., in a state of decomposition, resulting from contact with air. There was no fermentation known in which these nitrogenous substances were not present and active. One character of fermentations, as well as of diseases, was that they were spontaneous in their origin and development. In order to show that the hypothesis of the learned German chemist was, to use his own words, "but a deceitful illusion," I made up artificial mixtures whose only constituents were as follows:—Water, the mineral constituents essential to life, fermentable substances, and the germs of the ferments which act on these substances. With these mixtures, fermentation took place with a regularity and a purity, if I may use the word, which are never found in the spontaneous fermentation of nature. As every albuminoid substance had been excluded from these mixtures, the ferment appeared as a living being, which borrowed from the fermentable substance all the carbon of its successive generations, and, from the mineral constituents, the nitrogen, phosphorus, potassium, magnesium—elements, the assimilation of which is an indispensable condition to the formation of all living beings, be they great or small.

After these experiments, not only was the theory o Liebig left without any foundation, but the phenomena of fermentation presented themselves as simple phenomena of nutrition, taking place in exceptional conditions, the most extraordinary of which is the possible absence of any contact with air.

Human, as well as veterinary, medicine made use of the light which shone from these new results. Many investigators made experiments to discover if every virus or contagion was not an animated being. Dr. Davaine, in 1863, endeavoured to show the functions of the *bacteridia* of carbuncular disease, which he had discovered in 1850. In 1868, Dr. Chauveau tried to show that virulence was due to the solid particles previously noticed in every virus. Dr. Klebs, in 1872, attributed traumatic virus to microscopic organisms. In 1872, Dr. Kock obtained, by artificial cultivation, the germs of *bacteridia*, which were similar in every respect to those which I had pointed out in *vibrios* (1865-70), and the causes of several other diseases were ascribed to microscopic organisms. To-day those who are most opposed to the theory of germs are wavering. Still the greatest obscurity prevails on the most important points.

In the great majority of virulent diseases, the virus has not as yet been isolated, and still less has it been shown, by artificial cultivation, that it is a living organism, and everything contributes to make us regard these "unknown quantities" of pathology as mysterious morbific causes. The study of the diseases which they cause presents many extraordinary circumstances, among which the most remarkable is their non-recurrence. Human imagination can hardly venture to present a hypothetical explanation having any experimental foundation. Is it not still more surprising to find that vaccine, a virulent but mild disease, is a preventive, not only of vaccine itself, but of a more serious disease—the small pox? These facts were known from the remotest antiquity. Variolisation and vaccination have been practised in India from immemorial times, and when Jenner demonstrated the efficacy of vaccination, the common people of the locality in which he practised medicine knew that cow-pox was a preservative from variola.

Vaccination appears as an isolated fact, but the non-recurrence of virulent diseases appears to be general. The organism does not go twice through measles, scarlatina, typhus, the plague, variola, syphilis, &c.; at least it may be said that the immunity persists for a certain time.

Although in the presence of such mysteries, it behoves us to be humble, I dare to hope that the Academy will find that the facts which I am about to have the honour of presenting before it throw unexpected light on the problems raised by the study of virulent diseases.

There occurs sometimes in poultry yards a fearful disease, commonly called chicken cholera. The victim overtaken by it loses its strength, and stumbles about with drooping wings. Its feathers stand on end, and give it the appearance of a ball; its seem overcome by drowsiness; if we open its eyes it seems to awake from profound sleep, and soon its eyelids close again. Generally death comes after a dumb agony, without the victim even moving from the position it has occupied during the last stages of the disease. In rare cases, it beats its wings for a few seconds. The internal disorders are of the most serious nature. This disease is caused by a microscopic organism which, according to Tundel's Dictionary, was first suspected by M. Moritz, a veterinary surgeon in upper Alsatia; which was drawn more accurately, in 1878, by M. Peroncito, a veterinary surgeon in Turin; and which was found again, in 1879, by M. Toussaint, professor at the Veterinary School of Alfort, who demonstrated, by cultivation in neutralised urine, that this organism was the cause of the virulence in the blood.

* Translated from the *Comptes Rendus de l'Academie des Sciences*, of February 9, 1880, page 239, by P. Casamajor. From the *Journal of the American Chemical Society*, vol, ii.

In the study of microscopic parasites, the first, the most useful, condition to fulfil, is to obtain a liquid in which the infectious organism may be cultivated with ease, and without any admixture of other organisms of different species. Neutralised urine, which I have used with so much success to show that the product obtained by the cultivation of the *bacteridia* of Davaine, is identical with the virus of carbuncular disease (1877, Pasteur and Jaubert), does not fulfil the double end in view. But a liquid marvellously adapted to the life of the germ of chicken cholera, is a broth made from chicken's muscles, neutralised with potassa, and made sterile by a temperature superior to 100° C. (110° to 115°). The ease with which the microscopic organism multiplies in this liquid seems prodigious. In a few hours, the most limpid broth becomes turbid, and is filled with an infinite multitude of small articulations of extreme tenuity, slightly thinner in the middle, and which at first sight have the appearance of isolated dots. These small articulations have no motion of their own, and they certainly belong to a very different group from that of *vibrios*. I imagine that they will be classified some day with other forms of virus, now unknown, when we cultivate these, as I hope we are on the eve of doing.

The cultivation of this microscopic organism presents some very interesting peculiarities.

In my former researches, one of the liquids which I used with the greatest success, was a decoction of beer-yeast in water, after filtering it to obtain it perfectly limpid, and after rendering it sterile by a temperature superior to 100° C. The most various microscopic organisms thrive on the food presented by this liquid, particularly after being neutralised. For instance, the *bacteridia* of carbuncular disease multiplies surprisingly in a few hours. It is a strange thing that this liquid is entirely unsuited to the life of the organism of chicken cholera, which dies in it in less than forty-eight hours. Is not this entirely analogous to what happens when a microscopic organism is entirely innocuous towards an animal on which it has been inoculated? It remains inoffensive because it does not develop in the body of the animal, and it does not reach the organs essential to life.

The sterility of the decoction of yeast, with respect to the microscopic organism of chicken cholera, affords us an excellent criterion for the purity of the cultivation of this organism in chicken broth. If the cultivation be pure, upon transferring it to a decoction of yeast, no development takes place, and the yeast solution remains limpid. If, however, other organisms are present, they are developed, and the solution becomes turbid. I will, in the next place, call your attention to a still more extraordinary peculiarity of the cultivation of the germ of chicken cholera. The inoculation of this organism on guinea pigs is not so surely fatal as in the case of chickens. In guinea pigs, particularly in the older animals, the only thing that can be observed is a local lesion, at the point of inoculation, which ends in an abscess, of greater or lesser volume. This abscess opens spontaneously and heals, and meanwhile the guinea pig eats his food as usual, and seems to possess all the characteristics of health. These abscesses last sometimes for several weeks before discharging, being surrounded by a membrane full of creamy pus, in which the microscopic organism exists in infinite numbers, side by side with the globules of pus. It is the life of the inoculated organisms which causes the abscess, which is as a closed vessel, from which we may obtain the organism without endangering the life of the animal. The microscopic organism remains, mixed with pus, in a great state of purity, without losing its vitality. This may be proved by inoculating on chickens a small portion of the contents of the abscess. From the effect of these inoculations, the chickens very soon die, while the guinea pig, which has furnished the virus, is entirely cured after a short time. This is an instance of the localised evolution of a microscopic organism, which causes the formation of pus and of a closed abscess, without, at the same time, causing internal disturbances or the death of the animal on which it exists. It is, however, always able to cause the death of other species on which it may be inoculated, and even the death of the animal on which it exists in a closed abscess, if through some fortuitous circumstances, it should pass into the blood or into the viscera. Chickens and rabbits, living in company with guinea pigs, affected with abscesses of this kind, might, all at once, sicken and die, without any great change being observable in the health of the guinea pigs. This could easily happen if the abscesses of the guinea pigs discharged a small portion of their contents on the food of the chickens and rabbits.

An observer who witnessed these facts, and was ignorant of all the points, might well be astonished to see chickens and rabbits die in great numbers, without any apparent cause, and he would be apt to believe in some spontaneous disease. Certainly, he would not suppose that the guinea pigs were the cause of all the trouble, when he saw them all in good health, and particularly if he knew that the guinea pigs themselves often suffer from the same disease. Many of the mysteries in the history of contagions will some day be solved in easier ways than the one I have just mentioned. We may reject theories which are in contradiction with known facts, but we must not reject them solely because some of their applications elude our grasp. The combinations of nature are both simpler and more varied than those of human imagination.

I may easily convince you of the truth of these statements, if I add that, if a few drops from a cultivation of our microscopic organism, be placed on bread or meat given to chickens, they are sufficient to propagate the evil to their intestines, in which the little organism propagates with such remarkable rapidity, that the excrements of chickens so poisoned cause the death of those on whom they are inoculated. These facts enable us to understand the manner in which this fearful disease develops in poultry yards. Evidently, the excrements of the diseased chickens have most to do with the contagion. Nothing would be easier than to prevent the spread of the disease by isolating the chickens for only a few days; by washing the poultry yard with plenty of water, and particularly with water containing a little sulphuric acid, which kills the germ of this disease. The excrements should be carried off to a distance. After a few days, the chickens that are still alive could be brought together again with perfect safety, because this disease is so rapidly fatal that in a short time all the diseased animals would be dead.

If the cultivation of the infectious organism in chicken broth is repeated many times over, by passing from one cultivation to the next by sowing an infinitely small quantity, such as may be gathered on the point of a needle, the virulence of the germ is not weakened by the process. This is analogous to the ease with which it multiplies in the bodies of the *Gallinaceæ*. This virulence is so great, that the inoculation of a minute fraction of a drop will cause death in two or three days, and most generally in less than twenty-four hours.

Having established these preliminaries, I now come to the most important portion of this communication.

By operating certain changes in the process of cultivation, the virulence of the infectious germ may be much lessened. This is the vital part of the subject. I beg the Academy's permission to withhold a description of the processes by means of which I determine this diminution of virulence. My object is to insure independence in my studies.

The diminution of virulence is seen in cultivations by a slower development of the infectious organism, but, in reality, the two varieties of virus are identical. In the first or very infectious state, the inoculated germ may kill twenty times in twenty. In the milder state, it may twenty times in twenty give rise to illness, but not to death. These facts have an importance which is easily understood, as they allow us to form an opinion, in this particular disease, of the problem of its recidivation or non-recidivation. If we take forty chickens, and inoculate

twenty of them with the very virulent virus, these twenty will die. If we inoculate the other twenty with attenuated virus, these will all be ill, but they will not die. We let the twenty chickens be entirely cured, and then if we inoculate them with the very infectious virus, they will not die. The conclusion from this is evident. The disease is its own preventive. It has the character of virulent disease, which do not recidivate.

Let us not be astonished at the singularity of this result. All things are not here as new as they appear at first. In one important particular, however, there is a novelty which will be pointed out. Before the time of Jenner, who himself practised this method, as I have already mentioned, there was a practice of inoculating variola to preserve from variola. In our day, sheep are inoculated with murrain to preserve them from murrain, and cattle are inoculated with peripneumonia to preserve from this fearful discease. Chicken cholera shows us an immunity of the same kind. It is an interesting fact, but it does not show any theoretical novelty. There is, however, an important novelty in the preceding observations, a novelty which gives food for reflection on the nature of virus. It consists in this, that we have here a disease whose virulent cause is a microscopic parasite, which may be cultivated outside of the animal economy. The virus of variola, the virus of vaccine, those of glanders, syphilis, the plague, &c., are unknown in their nature.

This new virus is a living organism, and the disease to which it gives rise has one thing in common with virulent diseases, properly so-called, a quality heretofore unknown in virulent diseases, caused by microscopic parasites: it is that it does not recidivate.

The existence of this disease is a connecting link between virulent diseases caused by a living virus, and other diseases, in the virus of which life has never been recognised.

I would not have it believed that the facts present the constancy and mathematical regularity which I have mentioned. To believe this would be to ignore the great variability in the constitution of animals, taken at hap hazard from among domestic animals, and also the variability in the manifestations of life in general. The very virulent virus of chicken cholera does not always kill twenty times in twenty. Sometimes this virus only kills eighteen times in twenty, but generally twenty times in twenty. We may also remark that the virus, when reduced in virulence, does not save life twenty times in twenty. Sometimes this happens only eighteen times in twenty, and even sixteen in twenty. Neither is it an *absolute* preservative by one inoculation. We may more surely prevent recidivation by two than by one inoculation.

If we compare the results above stated with what is known of vaccine and its relations to variola, we may see that the less vigorous organism which does not cause death, is analogous to a vaccine, relatively to the one that kills, for it gives rise to a disease which may be called mild, as it does not cause death, and, at the same time, it preserves from the disease in its most deadly shape. What other condition must this organism fulfil to be a true vaccine like that of cow-pox? This condition is that it should be a definite variety, and that we should not be obliged to prepare it *de novo*, when we wish to use it. We find here the same difficulty which presented itself to Jenner. After he had demonstrated that inoculated cow-pox is a preservative against variola, he thought that it was necessary to start from the cow-pox of a cow. Jenner soon discovered, however, that he could get along without cows, and make vaccine pass from one arm to another. We may try to do the same by causing our germ to pass from one cultivation to another. Under these circumstances, will the germ become actively virulent or will it remain moderately so? Although this may appear very astonishing, I can say that the last supposition is the correct one. The virulence of the germ, in the small number of cultivations which I have attempted, has not increased, and everything seems to point to the existence of a true vaccine. I may even add that one or two trials favour the idea that the attenuated virus keeps its character of mildness after passing through the bodies of Guinea pigs. Will the same thing happen after repeated cultivations and repeated inoculations? Only by experiments can such a question be answered.

At any rate, we now know of a disease caused by a microscopic parasite, which may be obtained in such a condition that it does not recidivate, as other diseases caused by similar parasites. Moreover, we have a variety of its virus, which behaves towards it as vaccine towards variola.

The Academy may allow me a digression worthy of attention. From what has been said, we can easily obtain chickens affected with the disease called *chicken cholera*, in which death is not a necessary consequence of the disease. We may then witness as many cases of cure as we may wish. Now, I do not believe that experimental surgery has ever met with more curious phenomena than those which are present when the animal returns to health, after inoculations have been made in the large pectoral muscles. The germ of the disease multiplies in the substance of the muscle as it would in a vessel. At the same time the muscle swells, hardens, and becomes bleached at the surface and below the surface. It becomes filled with globules of pus, but does not suppurate. Its histological elements are easily torn, because the parasitical germ is scattered through them in numerous pockets, and it feeds on a portion of their substance. I will, later on, exhibit coloured figures showing the disorders caused by the parasitical germ in case of cure. The parasite is gradually arrested in its development and disappears, while, at the same time, the portion of muscle which has been attacked unites, hardens, and lodges itself in a cavity whose surface resembles that of a healthy granulating wound. The portion which has suffered from the disease finally forms a sequestrum, and is so well isolated in the cavity that holds it that it may be felt by the finger under the skin, and, by the least incision, it may be seized with forceps and extracted. The small wound left in the skin heals immediately, and the cavity is gradually filled by the renewed elements of the muscle. I will now place some of these demonstrations before the Academy.

I have now to close by an explanation relating to the non-recidivation of the disease which occupies our attention. Let us take a chicken thoroughly vaccinated by one or more previous inoculations of the enfeebled virus. What will happen if we inoculate the same chicken again? The local lesion will be insignificant, while the first inoculations, and, in particular, the very first, had been the cause of such marked change in the muscle, that a large sequestrum can be easily felt by the touch. The cause of the difference in the effects of these inoculations is to be found entirely in a greater relative facility of the development of the germ of the disease at the first inoculations, and, in the last inoculation, in the development being either entirely wanting or very feeble and promptly stopped. The consequence of this seems evident, and it is that the muscle, which has been seriously diseased, has become, even after it has been cured, unfit for the cultivation of the germ of the disease, as if this germ, by a preceding cultivation, had suppressed some principle which life does not bring back, and whose absence prevents the development of the microscopic organism. I have no doubt that this explanation, to which we are led by palpable facts in this case, will be found to be generally applicable to all virulent diseases.

It must appear superfluous to point out the principal consequences of the facts which I have had the honour to present before this Academy. There are, however, two of these which may be mentioned. One is, that we may hope to obtain artificial cultivations of every virus, and the other is, the idea of obtaining vaccines of the virulent diseases which afflict humanity, and which are the greatest plague of agriculture in the breeding of domestic animals.

It is a duty and a pleasure for me to add that in these delicate and lengthened researches I have been assisted with great zeal and intelligence by Messrs. Chamberland and Roux.

ON THE

PREPARATION OF METHYLENE CHLORIDE, AND DIOXYETHYL-METHYLENE.

By W. H. GREENE, M.D.

WITH the exception of the diethyl ether of methylene glycol, all of the oxyethyl substitution compounds of methane have already been described. Ortho-formic-ether, $CH(OC_2H_5)_3$, was studied by Kay and Williamson, and is generally known as Kay's ether. Ortho-carbonic ether, $C(OC_2H_5)_4$, was discovered and described by H. Bassett. Methyl-ethyl ether has long been known.

By a reaction similar to that by which these ethers are formed, I have isolated dioxyethyl-methylene, the reaction between sodium ethylate and methylene chloride taking place as indicated by theory.

The chief difficulty lies in the preparation of pure methylene chloride. The process described by Perkin, and depending upon the reduction of chloroform by zinc and ammonia, yields only small quantities of methylene chloride, and the direct chlorination of methyl chloride gives equally unsatisfactory results. The method which, after numerous experiments, I have found to answer best, consists in the reduction of an alcoholic solution of chloroform by zinc and hydrochloric acid.

The zinc and chloroform (mixed with several times its volume of alcohol) are placed in a flask connected with a suitable condensing apparatus, and hydrochloric acid is added in small portions. The reaction develops considerable heat, and methylene chloride and chloroform distil over; when the reaction has somewhat subsided, and no more liquid distils, more hydrochloric acid is added, and a moderate heat applied, if necessary. In any case, the mixture is heated towards the close of the operation, until alcohol begins to distil in quantity. The operation is then arrested, and the product in the receiver is washed, dried, and rectified, that portion which passes below about 53° being retained. The residue is returned to the flask, and again submitted to the action of the zinc and hydrochloric acid. By several careful rectifications of the product passing below 53°, pure methylene chloride, boiling at 40—41°, is obtained.

By several operations in this manner, the yield of methylene chloride may be brought up to about twenty per cent of the chloroform employed.

Little or no advantage is gained by attempting to fractionate the product as it distils from the flask, so that the chloroform may flow back into the reducing mixture, for such distillation necessarily takes place in the stream of hydrogen, which carries with it about as much chloroform as methylene chloride.

Dioxyethyl-methylene.—This compound was prepared by gradually introducing one molecule of sodium into a mixture of one molecule of methylene chloride and about four times the theoretical quantity of absolute alcohol, contained in a flask connected with a reflux condenser. After all of the sodium has been introduced, the mixture is heated on a water-bath for about an hour, and is then distilled. The distillate is fractionated, and the portion which passes below 78° contains all of the diethyl ether. It is agitated with a tolerably concentrated solution of calcium chloride, and the light etherial layer is separated, dried over calcium chloride, and carefully rectified, that portion being retained which passes between 86° and 89°.

Dioxyethyl-methylene, so obtained, is an etherial liquid, having a penetrating, pleasant odour, somewhat recalling that of mint. Its specific gravity at 0° is 0·851, and it boils at 89°, under a pressure of 769 millimetres. It is slightly soluble in water, from which it may be separated by the addition of calcium chloride; it mixes in all proportions with ether and alcohol, and cannot readily be separated from its alcoholic solution if much alcohol be present; in such a case, fractional distillation, and treatment of the portion which passes below 78°, with solution of calcium chloride, effect the separation.—*Journal of the American Chemical Society.*

ACTION OF BENZO-TRICHLORIDE ON PRIMARY AMINES.

By JAMES H. STEBBINS, Jr., B.S.

O. DOEBNER has shown, by his experiments on "malachite green" (*Ber. Chem. Gesell.*, ii., 1236), that benzo-trichloride will only unite with tertiary amines, in the presence of zinc or aluminium chlorides.

Now, it occurred to me, that some of the primary amines might unite directly with benzo-trichloride, without the aid of metallic chlorides, to form some new and interesting compounds.

Therefore, acting on this principle, I took para-toluidine as my starting point, as I happened to have quite a quantity of the latter at my disposal, and I think that the following experiments justify (as far as I have proceeded) the above-stated theory.

If equal molecules of benzo-trichloride ($C_6H_5C=Cl_3$) and para-toluidine ($C_6H_4CH_3NH_2$) be allowed to react on one another, at the ordinary temperature, the mixture soon grows very warm, and gives off copious fumes of HCl, mixed with aqueous vapour. The reaction is ended when the fumes are no longer evolved, and the white granulated mass thus obtained is dissolved in strong alcohol, from which it crystallises on cooling in two forms, namely—those obtained by slow cooling are long, white needles, having a strong, vitreous lustre, and melting at 155° C., and those produced by rapid cooling are small, white, rhombic prisms.

If the substance be heated a little over its melting-point, it sublimes, producing small, white needles which appear to be the original compound unaltered.

It is only sparingly soluble in boiling water and HCl, but is quite soluble in acetic acid.

Strong H_2SO_4 dissolves it readily, giving off fumes of hydrochloric acid, and it is precipitated, probably free from chlorine, by the addition of cold water.

This compound, then, is neither a base nor an acid, and its constitution can only be explained by converting it by oxidation or reduction, into a substance of known composition, and I think that this problem can easily be solved by its property of producing, first a red, then a black precipitate, with a solution of potassic permanganate.

The precipitate thus formed is collected on a filter, washed with a little water, and then boiled for a short time with strong alcohol, and filtered rapidly. On cooling, fine yellow-coloured needles make their appearance, the constitution of which, as well as that of the mother substance, I hope to lay before you at the next meeting.—*Journal of the American Chemical Society.*

ARTIFICIAL INDIGO.

IT is said that Prof. Baeyer has discovered a method of obtaining artificial indigo which is practicable on a commercial scale. The patent has been assigned to the Baden Aniline Company. The indigo is obtained from isatine chloride, which in turn is produced from benzol.—*M. Reimann's Faerber Zeitung*, No. 2.

LABORATORY NOTES.

By H. ENDEMANN, Ph.D., and GEO. A. PROCHAZKA, Ph.D.

I. STANDARD SODA SOLUTION.

GERRESHEIM has published in the first volume of the *Annalen der Chemie*, for the year 1879, an article on ammoniacal mercury compounds, wherein he calls attention to the pronounced basic properties of the so-called Millon's base, which is obtained by the action of ammonia upon mercuric oxide. He states that a soda solution to which hydrochloric and sulphuric acid, &c., have been added, can be freed from these by shaking with Millon's base. Mercury is not found in the solution. We have made use of this method in order to obtain a chemically pure standard soda solution from the ordinary so-called pure caustic soda, and have found all which the author claims verified. The soda contained large quantities of chlorine, sulphuric acid, and, also, silicic acid and carbonic acid. We employed for 2 litres soda solution about 30 grms. of Millon's base. The chlorine disappeared first, than carbonic acid, silicic acid, and sulphuric acid. The process was complete after about one week's standing, the mixture being shaken about once or twice each day.

We allow the Millon's base to settle in the solution, and draw off with a syphon as required. Shaking from time to time removes any carbonic acid which may be absorbed by the soda in the course of time. Millon's base absorbs carbonic acid from the air rapidly, and is, also, not easily filtered and washed. It was, therefore, not completely washed free from the last traces of ammonia, as we preferred to remove these by the addition of a small quantity of mercuric oxide when the Millon's base was brought into the soda solution.

II. HYDROBROMIC ACID AS A VERY DELICATE TEST FOR COPPER.

A solution of cupric bromide is blue; if the same is evaporated, the solution turns, at first, dark reddish-brown, leaving finally the anhydrous bromide as an almost black mass.

The dehydration can also be produced by the addition of a concentrated solution of hydrobromic acid; if, therefore, to a dilute solution of a copper salt concentrated hydrobromic acid is added, a dark brownish-red or violet colour is at once produced.

This reaction is so delicate that $\frac{1}{100}$ milligrm. of copper can be detected with certainty. One drop of a solution containing this small quantity of copper is brought on a watch glass, then one drop of hydrobromic acid is added, and the solution is then allowed to evaporate slowly by standing the glass on a warm place. When the whole has been concentrated to about one drop, this will distinctly show a rose-red colour. The colour thus produced is about three or four times as distinct as the one which is obtained by the addition of ferrocyanide of potassium. Of other metals which are examined in this direction, we find only iron to be apt to interfere with this reaction, and then only when it is present in considerable quantity.

We think that this reaction may also be utilised as a colorimetric test for the quantitative determination of small quantities of copper.

III. OBSERVATIONS MADE IN AN EXAMINATION OF SWEET POTATOES.

(*a.*) *Parasites on Batata edulis.*—We will first mention here *Acarus sacchari*, the sugar mite, which is commonly found in raw sugars. A second parasite is *Mucor mucedo*, which produces a sweet potato rot very similar to that produced by perenospera on the ordinary potato.

The mycelium of *Mucor mucedo* travels soon into the interior plant, and can be followed with the microscope to a certain depth; it then, however, disappears, and from that point on the potato is rapidly destroyed by bacteria. An infection by either *Mucor mucedo*, or the bacteria, is equally effective in destroying the potato, which soon becomes soft throughout.

A similar, but by far not so rapid, result is reached if the infection is produced by *Aspergillus niger*. *Aspergillus glaucus* and *Penicillium glaucum* do not produce the sweet potato rot. The question whether *Mucor mucedo* has merely been effective in preparing the ground for a healthy development of the bacteria, or whether these organisms are merely a lower organised shape of *Mucor mucedo*, we will not decide, but must leave this to the study of botanists.

A peculiar odour produced during this fermentation bears great resemblance to the odour of rose geranium.

(*b.*) *Chemical examination.*—In making this, it was our endeavour to obtain a certain substance, presumably a glucoside, in larger quantities. This we obtained, but not in such purity as we desired. A certain quantity of fat has adhered to it all along, and our efforts to find a method of separation have thus far been in vain.

The sugar of the sweet potato has never been designated—most authors calling it simply sugar, without going into details. Ledoux, in his last report on the work of the experimental station at Chapel Hill, N.C., calls the sugar, glucose. We will state, therefore, that we have obtained this sugar in crystals, which, to all appearances, are cane sugar.—*Journal of the American Chemical Society.*

ANALYSES OF SOME HAIR-DYES.

By J. F. BRAGA.

(Continued from vol. xli., p. 278.)

Silver.—One dye I found to consist of simply a solution of nitrate of silver in water, the quantity of salt being at the rate of 10 grms. per litre. On enquiry I ascertained that this dye, though entirely successful when first applied, produced after a time a peculiar reddish brown tint upon the hair stained with it, this disagreeable hue being very noticeable in some aspects, as when the light reflected meets the observer's eye at a wide angle. This defect is entirely remedied by the presence of a minute quantity of copper in the solution, though it appears that copper salts alone are not successful as hair-dyes.

Silver and Copper.—Of this sort I have examined several. They are all blue in colour and alkaline in reaction, these characteristics being due to the presence of an ammonio-salt of copper, either nitrate or sulphate. One specimen contained a considerable excess of ammonia, whereas the others contained not much more than sufficient to redissolve the hydrates of silver and copper at first thrown down by it.

I have not found the quantities of the ingredients to vary much, so I need only quote the following formula, which is typical: by it I succeded in imitating one specimen after an analysis followed by an accurate determination of the metals:—

Nitrate of silver	26 grms.
Nitrate (or sulphate) of copper..	2·5 ,,
Ammonia	a sufficiency.
Distilled water	to one litre.

The salts being dissolved in about 250 c.c. of water, strong liquor ammonia is gradually added till the precipitate is *just* re-dissolved, the solution being then diluted to the volume of 1 litre. Some of them contained a little alcohol, but I have not detected glycerin in any.

Another silver dye—called instantaneous, and sold under a great number of different names—consists of an aqueous solution of silver and copper salts, of about the strength given above, in one bottle, and a solution of pyrogallic acid, strongly acidified with acetic acid in another bottle. This latter solution, it appears, is first applied to the hair, which is then suffered to get almost dry; when the other solution is put on the well-known reaction occurs, the hair becoming immediately stained *jet black* if the solution of

pyrogallic acid be strong, or a brown if that solution be very weak (about 1 to 2 grms. per litre). I have found the strength of the pyrogallic acid solution to vary in different specimens from about 10 grms. to 50 grms. in 1 litre, while the quantity of silver nitrate varied 10 to 60 grms. per litre, and that of the copper salt from 0 to 13 grms. per litre. Two specimens of this dye, obtained from different makers, had this solution of metals made alkaline with ammonia, a sufficiency being used to just re-dissolve the hydrates, as before mentioned.

PHYSICAL SOCIETY.

June 26, 1880.

Prof. W. G. ADAMS in the Chair.

Mr. C. V. BOYS read a paper by Prof. Guthrie and himself "*On the Measurement of the Conductivity of Liquids by means of Magneto-Electric Induction.*" The liquid is suspended in a glass vessel by a fine iron wire in the centre of a cylindrical electro-magnet formed of two semicircular parts. This electro-magnet is rotated at a velocity not exceeding 3000 turns per minute, and the liquid being drawn round in the direction of rotation, the wire is subjected to torsion which, under correction for certain errors, is proportional to the resistance of the liquid. The torsion is observed by means of a scale and microscope. The results plotted in a curve agree very closely with those of Kohlrausch obtained by alternate currents, and Dr. Guthrie thinks that they are probably more correct and trustworthy than Kohlrausch's, for the motion would seem to be superior, and the curve contains fewer eccentric points than his.

Dr. GLADSTONE read a paper "*On the Refraction Equivalents of Isomeric Bodies*," in which he described the present state of the subject and his own contributions to it. He showed that the refractive power of bodies over light was of great importance to chemists, since it depended on their essential structure.

Dr. HUGGINS described his latest results of star-spectra, and illustrated his remarks by photographic spectra taken by his improved method. From these it appears certain stars, such as Vega, gives a complete spectrum of hydrogen. Others, more yellowish in colour, show a thinning of these lines, such as Sirius and Ursa Majoris. Others show the intrusion of more refrangible lines—for example, Arcturus, Aquila, and Virginius, while Capella gives a complex spectrum like that of the sun. Dr. Huggins also showed a spectrum of the flame of a spirit-lamp, which present a strong group of lines at S, and he considered it to represent the light emitted by the molecules of water. He further observed that the spectrum offered a highly sensitive test of the presence of carbon.

Mr. LIVEING exhibited a new fire-damp indicator, capable of detecting $\frac{1}{4}$ per cent. of marsh-gas in air. It is based on the fact that an incandescent body shows more brilliantly in proportion to the amount of marsh-gas in the air, and consists of two fine platinum wires kept incandescent by a magneto-electric current sent through them in one circuit. One wire is excluded from the fire-damp; the other is exposed to it, and the relative intensities of the two glowing wires is compared by a photometric screen placed between them, and adjustible to a position between them at which the reflections of the wires on the screen are as equal in intensity. The position of the screen relatively to the wires is given by a scale, and measures the proportion of fire-damp in the air. The contrivance is more advantageous than the safety lamp, which only indicates 2 per cent. of marsh-gas in the air.

Dr. STONE explained a new vacuum shunt for induction currents devised by himself and Dr. Keiler. It consists of a mercury barometer tube with Torricellian vacuum and a movable cistern, suspended by a cord over a pulley, and supported by a counterpoise. By raising or lowering the cistern (which is connected to the tube by an india-rubber pipe) the mercury column is also raised or lowered, and the length of the vacuum—that is, the resistance of the shunt—altered.

Mr. MACFARLANE GRAY read a paper "*On Specific Heats calculated from Entropy.*" The author arrives at some remarkable results, which will be found in his paper in the Proceedings of the Society. He also explained a new graphic method of representing entropy.

Mr. CLARK communicated a paper "*On the Behaviour of Liquids and Gases near their Critical Temperatures.*" When a sealed tube containing a capillary tube dipping into alcohol, ether, or sulphurous anhydride, is heated, the liquid sinks in the capillary tube and rises by expansion in the outer tube. Between 2 and 3° C. below the critical temperature of these liquids both surfaces become level, and, on continuing to heat, the concave capillary meniscus is seen below that in the outer tube. The extent of this depression depends upon the diameter, &c., of the capillary tube, and on the nature of its internal surface. As stated in June, 1879, when the capillary tube dips but very slightly below the surface the liquid disappears at the same level in the capillary and external tube at the critical temperature. Long contact of the liquid with the capillary tube may also cause the depression to be absent the first time of heating. (1.) The depression results from a surface action between the liquid and inner glass surface of the capillary tube. (2.) Surfaces exercise an appreciable action in determining the position at which the condensation of liquid takes place in the external tube on rapid cooling. (3.) Near the critical temperature the surface of a liquid (particularly in an external tube 20 m.m.) appears convex when really slightly concave. This is the result of refraction. (4.) The black, ill-defined band which immediately succeeds the disappearance of the liquid surface is a result of too rapid heating, and probably due to the mixture of the liquid and its vapour when of nearly equal density. Very slowly heated, the defined concave surface is gradually obliterated, and is last seen as a very fine and often waving line. Under these circumstances the disappearance-volume of the liquid is much greater than it is when rapidly heated. Rapidly cooled the liquids reappear at a lower temperature (about 2° C.) and smaller volume than that at which they become gases under the same conditions on heating.

Mr. WINSTANLEY explained two new varieties of air thermometers and a thermograph actuated by an air thermometer on the principle of his radiograph exhibited at the last meeting. The first thermometer consists of a tube with terminal bulbs, and the left leg of much finer bore than the right. Mercury is in the right leg; sulphuric acid surmounted with air in the left. The apparatus is a barometer to the air inside the left bulb and a thermometer to that outside. A similar combination of an air thermometer and an Aneroid barometer constitutes the second instrument. The expansion or contraction of the air in the stem by external temperature expands or compresses a small aneroid chamber in the bulb.

Mr. GEE and Mr. STROUD made a communication "*On a Modification of Bunsen's Calometer*," which will be found in the Proceedings of the Society. The meeting then adjourned till the winter session commences.

The Distribution of Light in the Spectrum.—J. Macé and W. Nicati.—In order to measure the distribution of luminous intensity in the spectrum it is necessary to take, as the starting point, a physiological fact, well defined, and independent of colour. They consider two quantities of light as respectively equal when they, illuminating one and the same colourless object, placed at the same distance from the same observer, enable him to see its details with the same distinctness.—*Comptes Rendus.*

CORRESPONDENCE.

COMPOSITION OF WELDON MUD.

To the Editor of the Chemical News.

SIR,—Dr. Post, in the CHEMICAL NEWS (vol. xli., p. 276), attributes to me a formula, to satisfy which, he says, would require that the 0·58 per cent of Mg, which he found in a certain sample of Weldon mud, should be combined with 4·20 per cent, or 2·0 equivalents of MnO_2, and would further require that the 0·60 per cent of Fe_2O_3, which he also found in that sample, should be combined with 1·305 per cent of MnO_2, or in the proportion of 4·0 of MnO_2 to 1·0 of Fe_2O_3. Will you allow me to say that I have never given any such formula. On the contrary, while I have proved that MgO and MnO_2 can be made to combine in the dry way, though not in the proportions given by Dr. Post, but only in that of 1·0 of MnO_2 to 2·0 of MgO, I have also proved that MnO_2 does not combine with MgO at all in the wet way under the conditions which obtain in the Weldon oxidiser, and under which CaO, SrO, BaO, Na_2O, and K_2O, all combine with MnO_2, and that neither in the wet way nor in the dry way, under any conditions yet realised, will MnO_2 combine either with Fe_2O_3 or any other sesquioxide whatever.

Alike in his communication to you, and in four papers previously contributed to German journals, Dr. Post maintains that his determination of the quantity of CaO in certain samples of Weldon mud, prove that the explanations which I have given of what takes place in the Weldon process are incorrect. I reply that Dr. Post failed to find in his samples all the lime really contained in them, and that if his acquaintance with the chemistry of the Weldon process were as complete as that of one who is endeavouring to set us all right about it should be, he would know that the theory that the results of that process are due to the formation of compounds of MnO_2 with CaO is quite compatible with the non-existence of any lime at all in finished mud, made, as all Weldon mud is now-a-days, with what is called "final liquor."

Some fifty thousand samples of Weldon mud are now analysed per annum. Since the process was first introduced, more than half a million samples have been analysed. Dr. Post has analysed only three or four samples. The half million results are on one side, Dr. Post's three or four results are on the other. It does happen sometimes that one man is right and all the rest of the world wrong. But in this case there are circumstances which make it immeasurably improbable that Dr. Post is right. Weldon mud is made for the purpose of obtaining, by means of it, chlorine-products for sale. Important elements in the cost price of chlorine-products are the quantities of lime and limestone required to produce the Weldon mud, and the quantity of acid required to dissolve it. These quantities are therefore recorded regularly in every chlorine-work in the world, and from them the composition of the mud can be calculated, due note being taken of any loss of free chlorine; and calculation from these data confirms the results of the half million analyses, and utterly condemns Dr. Post's. If Dr. Post's analyses were accurate, to produce the quantity of chlorine now manufactured per annum would require some 14,000 tons less lime, and some 70,000 tons less hydrochloric acid, than we know that it actually does require.

In a paper replying to Dr. Post's first two German papers on this subjects which I read before the Newcastle Chemical Society on the 25th March last, and to which I would beg to refer any of your readers who may care to enquire into the evidence for the existence of manganites, I have shown that the contents of the Weldon oxidiser, when oxidation has ceased to advance, before the addition of the "final liquor," consist partly of Mn_2O_3, but mainly of MnO_2 combined with CaO, partly as $CaOMnO_2$, or $CaMnO_3$, and partly as $CaO(MnO_2)_2$, or $CaMn_2O_5$. Now, when $CaOMnO_2$ is treated by a sufficient quantity of $MnCl_2$, two successive reactions take place; the first, which I will call A, being represented by the equation:—

$$2CaOMnO_2 + MnCl_2 = CaO(MnO_2)_2 + CaCl_2 + MnO;$$

and the second, which I will call C, by the equation:—

$$CaO(MnO_2)_2 + MnCl_2 = MnO(MnO_2)_2 + CaCl_2.$$

Reaction A takes place extremely readily, and is always completed before reaction C begins. Indeed, if there be any MgO present, aed if the $MnCl_2$ be added gradually, as it always is in practice, after reaction A has been completed and before reaction C begins, what I will call reaction B takes place, this being simply the decomposition of $MnCl_2$ by MgO. As reactions A and B yield free MnO, which can absorb oxygen, while reaction B moreover affords a simple means of avoiding the serious loss and inconvenience which would otherwise result from the accumulation in the mud of the MgO contained in the lime used, there is practical advantage in adding, as "final liquor," enough $MnCl_2$ to effect reactions A and B, and then continuing the injection of air until the resulting MnO has absorbed as much oxygen as it can; but there would be no advantage in adding more than that quantity of final $MnCl_2$, because the MnO resulting from the reaction of $MnCl_2$ on $CaO(MnO_2)_2$ simply replaces the CaO of that compound, converting it into $MnO(MnO_2)_2$, the MnO in which cannot be made to take up oxygen in the wet way. In well-conducted operations, therefore, no more final $MnCl_2$ is used than will convert all $CaOMnO_2$ into $CaO(MnO_2)_2$, and all MgO into $MgCl_2$. Still it does happen sometimes, exceptionally and by accident, that enough final $MnCl_2$ is added to produce, not only reactions A and B, but also reaction C, with the effect of replacing by $MnO(MnO_2)_2$ the $CaO(MnO_2)_2$ which would otherwise have been contained in the final product, and which is the principal constituent of the final product of operations made in the ordinary way. It follows that the complete absence of lime from finished Weldon mud would not, *of itself*, in the least vitiate the theory that the results obtained in the Weldon oxidiser are due to the intermediate formation of calcium manganites, and that whatever lime exists in finished mud which has been made with "final liquor," whether its quantity be great or small—and it may be very small indeed, even when reaction C has been entirely avoided, if the degree of oxidation of the manganese is low, owing to too small an "excess" of lime having been used—exists therein as $CaO(MnO_2)_2$. This is a very different theory from that which Dr. Post attributes to me, and it can neither be proved nor disproved by even accurate determinations of the quantity of CaO in the final product. To be in a position to discuss it at all, one must know the whole history of the product, and have observed qualitatively and quantitatively, all that has taken place from beginning to end of the operation by which it was made. And yet I am privileged to read, in an "abstract" in a recent number of the "Journal" of the Chemical Society, that Dr. Post's estimation of the CaO in certain samples of finished mud, "show the theories of Weldon . . . . to be inaccurate."

If, however, finished Weldon mud may contain no lime at all, and yet my theory as to the part which lime plays in the oxidiser *not* be inaccurate, why do I hold that the samples analysed by Dr. Post really contained more lime than he found in them? Let me put the answer as follows:—According to the half million analyses, the average proportion of "base" in Weldon mud is about 0·7, that is to say, per equivalent of MnO_2 in it there is usually seven-tenths, or nearly seven-tenths, of an equivalent of protoxides. This result of the half-million analyses is confirmed by the manufacturing result that for every kilogramme of chlorine liberated by means of Weldon mud, the quantity of hydrochloric acid at 32 per cent which is decomposed and neutralised by the mud, averages ten and a half kilogrammes, less the quantity afterwards neutralised by about 0·8 of a kilogramme of $CaCO_3$. But Dr. Post's analyses show very much less

than 0·7 of base. Some of them show as little as 0·39 of base. If he had operated upon exceptional samples, in which the $CaO(MnO_2)_2$, of normal finished mud had been replaced by $MnO(MnO_2)_2$, his samples might have contained as little lime as he found in them, or even none at all; but they would then have contained an exceptionally large proportion of MnO. He finds in them, however, only the normal proportion of MnO. If, then, his determinations of MnO are accurate, his determinations of CaO must be wrong.

Dr. Post imagines that his results are confirmed by an analysis of Dr. Lunge's. From Dr. Lunge's figures he draws the conclusion that Dr. Lunge's sample contained "no trace of CaO." But he arrives at that conclusion only by completely ignoring reaction B, and assuming that what almost certainly was $MgCl_2$ was MgO. Moreover, while the "base" in normal Weldon mud unquestionably consists chiefly of CaO, and only to a smaller extent of MnO, it may, as I have shown above, consist entirely of MnO; and while Dr. Lunge's figures do not show what the base in his sample consisted of, between Dr. Lunge's results and Dr. Post's there is the essential difference that Dr. Lunge's results do show a proportion of base in perfect accord with the quantity of lime required to produce Weldon mud and the quantity of acid required to dissolve it, whereas if Dr. Post's results were true, some of the matter put into the oxidiser, in the course of the operation by which his samples were made, must have become annihilated. Analyses which show that some of the matter used in making the product analysed has ceased to exist, cannot be accurate.

Believing, as he does, that he has proved that Weldon mud contains very much less base than corresponds with the quantity of lime used in making it, it is strange that Dr. Post should not have tested the soundness of that belief by ascertaining how much hydrochloric acid it decomposes and neutralises per unit of chlorine liberated by it therefrom. To omit doing that is like omitting to ascertain whether or not supposed diamonds are attackable by hydrofluoric acid.—I am, &c.

Walter Weldon.

Rede Hall, Burstow,
June 18, 1880.

CELLULOID.

To the Editor of the Chemical News.

Sir,—W. Donald would probably obtain full information by applying to the patentee, Daniel Spill, Esq., Chingford Hall, Leyton, Essex.

S. E. P.

THE NEW PATENT BILL.

To the Editor of the Chemical News.

Sir,—As an English inventor and patentee who has resided for some years in the United States, permit me to tender you my hearty thanks for your spirited and sagacious remarks on this subject, and especially for your comparison of the influence upon invention of the cheap American patent system (total Government tax £7 4s.) with that of our own expensive and, indeed, prohibitory tax (total Government charges £175).

It is as plain as a pike-staff to thinking men that in the coming years England cannot hold her own in the struggle with other manufacturing nations if legislation is to continue in this way to handicap the brain of the inventor.

As a labourer in saw mills, and at other times as mining and chemical engineer in Arizona, California, and Vancouver's Island, and thus mixing with Americans in all grades of life, I was constantly struck with the progressive spirit and inventing animus of the American artisan. Everywhere he appeared destitute of the class feelings and ideas which, in the form of struggles for higher wages or shorter time, seem alone to fill the head and heart of his British confrère. It is notorious that American strikes are in almost all cases got up, not by American, but by British or Continental workmen who have emigrated to the States. Whilst the Republican character of American life and institutions is, to a large extent, accountable for this peculiar spirit and sentiment of the native American artisan, there cannot be a doubt that one of its most important factors is the extreme facility with which he can secure possession of his inventions.

As a consequence, his brain is always at work scheming some new labour-saving or other appliance, whereas in England, as a rule, the tremendous Government tax of £25 (amounting, with agents' fees, principally for useless Government formalities, to nearly £40) during the first six months makes it hopeless for the workman to protect his discovery without first revealing it to some capitalist whose aid he is compelled to invoke.

In the chemical works where I write this (the largest of its kind on the globe) there is not one working man to whom I could truthfully point and say—"He has the inventing animus." The afflatus may exist, but in the entire absence of motive it is now hopelessly asleep.

Taking it as conceded, then, that the door to invention should be opened to the working man by lowering the initial charge for patents, we are met next by the consideration that if the tax in subsequent years be made extremely low, dead and worthless patents may be kept in force merely on the dog-in-the-manger principle of blocking the path for others. This is, I believe, recognised to be a very serious practical objection to the plan of low subsequent charges, and I would venture, therefore, after much thought upon the subject, to suggest the following scheme through the medium of your columns:—That, taking the duration of the patent to be 21 years, as now proposed, the first year's Government tax should be £1, the second year's £2, the third £3, and so on till the last year, when it would be £21. Under this arrangement no working man would be deterred from fully securing his invention. Impracticable or unprofitable patents would die a natural death (everybody knowing when they had given up the ghost), and the Government upon every patent which was worth keeping up for the full term would collect a tax (and that, too, in the least oppressive way) of £231.

The resulting revenue might be well utilised in perfecting the Patent Office publications, say by a prompt and regular weekly issue of abridgments of patents whose close time had expired. These abridgments to be drawn up by experts in every department, and to have an index attached giving full references to every abridgment issued since the appearance of the last yearly volume. The roll of special class abridgments should also all be completed up to within a year of date, and every other facility should be given to the intending inventor to ascertain exactly what had been done up to date in his special field. For want of these reasonable and simple arrangements incalculable loss is, to my certain knowledge, done every day to British invention, as inventors are, in numberless cases, afraid to dive into the mass of complicated indexes and unabridged patents (generally behind date) at present provided. A few years ago I obtained the signatures of leading British inventors and manufacturers to a memorial asking a weekly issue of abridgments with index incorporating weekly all previous indexes since the issue of the last yearly volume, the object being to keep every inventor thoroughly posted up to date in his particular department. The request was granted by the Patents' Commissioners, but as the abridgments given were the optional ones of the inventors (in many cases being mere titles!), and as the Commissioners would spend nothing in employing technical men to prepare the abridgments, the publication soon proved practically worthless, and was abandoned.

If, in addition to such perfecting of the publications, it were considered necessary or desirable for illiterate inventors to provide official technical examiners, the revenue

would, doubtless, defray their expenses, but such examiners should only have advisory powers. They might point out to an inventor where they considered his invention weak, but he should still have the full privilege of patenting his invention and taking the consequences of his act.—I am, &c.,

FRANK.

TAR DISTILLERS *v.* GAS COMPANIES.

To the Editor of the Chemical News.

SIR,—In your article on this subject in your last number you do not treat the tar distiller with your usual justice when you assert that he, unlike other manufacturers, has not been alive to the advantages of improvements in the processes of his business, and that few industries have suffered more in remaining so long in the background for want of scientific aid and direction. The success of the Gas Light Company with their tar works at Beckton, which you prophecy may possibly rival those of the Cie. Parisienne at some future time, and which are now actually on a much larger scale, does not warrant you, I think, in deciding so emphatically that the tar distillation of the future must be taken out of the hands of tar distillers and placed in those of gas companies.

I freely admit that there are tar distillers who are jogging on in the old ruts despite the great progress that has been made in the different improvements of the different processes of late years, but these men are in every case in a very small way of business, with very limited capital to carry out experimental work or improvements, even when they have the technical knowledge to do so; but I contend that these men have in the past been as successful and efficient distillers, and more so, than managers of small provincial gas works would have been if they had had this industry in charge.

The larger tar distillers of England and Scotland, I contend, will compare favourably with any other body of manufacturers, either as commercial men, or as possessing the technical knowledge of their business. Those of them who have not had scientific training themselves generally engage scientific assistance to ensure their working in the best manner and to improve on old processes.

That English distillers are not behind our French neighbours in adopting a new process or manufacturing a new product is evidenced by one instance, viz., the manufacture of anthracene, as this product was manufactured commercially by English distillers some considerable time before the Cie. Parisienne made it, although they had the assistance of their talented chemist, M. Audouin.

In conclusion, I would point out that the success of the Beckton Tar Works, so far from justifying you in your strictures on English tar distillers, on the contrary, points to the opposite conclusion, as the works were designed by a tar distiller for the company, and are now managed by a gentleman who, I believe, has been brought up to the tar distilling business.—I am, &c.,

TAR DISTILLER.

ACTION OF A NARROW SLIT ON LIGHT.

To the Editor of the Chemical News.

SIR,—I have just been reading "Effects of Light Passing Through a Slit," by Lieut.-Com. Michelson. It seems to me that no great difficulty obtrudes itself if we apply the vertical and horizontal theory of waves in light. The article closes by saying, "the experiments in any case seem to prove (1) that a very narrow slit polarises light, as described, and (2) that it lets the shorter waves of light pass more freely than the longer ones." This is just what we should expect had the premises been put before us. (1) The rays are in our plane only, the narrowness preventing* those at right angles getting through: this is borne out by the fact that the different reflecting angles of the different metals tried did not influence the result; it was purely, then, confined to some action in the ray itself (shown to be polarised, &c.). (2) This would (seem to) result in the smaller *amplitude* of the waves, when of course the lesser would get where the greater could not: this is proved by the violet succeeding to the blue.—I am, &c.,

D. G. CLIFF.

* Or supposing the planes at all angles, it only allows one to pass: thus the width is obtained.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 22, May 31, 1880.

An Automatic Electric Lamp.—M. Jamin.—This memoir cannot be intelligibly abstracted without the accompanying illustrations.

Heat of Combustion of the Principal Gaseous Hydrocarbons.—M. Berthelot.—The author gives for formene, 213·5; ethylene hydride, 388·8; ethylene, 341·4; acetylene, 318·1; methyl oxide, 344·2; propylene hydride, 556·0; propylene, 507·3; allylene, 466·5. The author concludes that the heat of combustion of a hydrocarbon is never equal to that of its elements.

Synthesis of Citric Acid.—E. Grimaux and P. Adam.—The authors prepared dichlorhydrin by means of glycerin and sulphur chloride, and oxidised it by means of potassium bichromate and sulphuric acid. The symmetric dichloraceton thus obtained was purified by combination with sodium bisulphite, and then heated in the water-bath with concentrated hydrocyanic acid. The cyano-dichlor-aceton was treated with hydrochloric acid; the product distilled in a vacuum, and exhausted with ether. The dichlor-acetonic acid obtained was saturated with sodium carbonate, and heated with 2 mols. potassium cyanide in a concentrated solution. The liquid contain sodium dicyan-acetonate which was saturated with gaseous hydrochloric acid, heated in the water-bath for fifteen hours, and distilled in a vacuum. From the residue the citric acid was extracted by careful treatment with milk of lime.

Researches on the Albuminoid Matters of the Crystalline Lens and Non-Identity of the Soluble Portion with Egg and Serum Albumen.—A. Béchamp.—The soluble albuminoid matters in question are *phacozymace*, a substance which remains soluble in water after it has been precipitated by alcohol. The solution, at a certain state of concentration begins to coagulate at 55°. It fluidifies starch paste. The solution in hydrochloric acid, takes a violet colour, after being heated for a few seconds to the boiling-point. *Crystal albumen* becomes insoluble in water after precipitation by alcohol, but this property is not manifested instantaneously. Both these bodies are thrown down in a plumbic combination by basic lead acetate, but these precipitates, unlike those formed by egg and blood albumens are not decomposed by carbonic acid.

Telephone with Magnetic Super-excitation.—M. Ader.—The new telephone is founded on the principle that if a slender blade of iron or steel is placed before the poles of a magnet, it is much more strongly acted upon if there is placed behind it a piece of soft iron than if this is not the case. Thus a greater sensibility is obtained by placing in front of the diaphragm of a common Bell's telephone, an iron disc pierced in its centre, with a hole corresponding to the mouth of the apparatus.

On Astigmatism.—C. J. A. Leroy.—A mathematical paper not susceptible of useful abridgment.

Heat Evolved in the Combustion of Certain Isomeric Alcohols of the Fatty Series, and of Œnanthol.—W. Louguinine.—The author's object is to ascertain if the kind of isomerism presented by the various alcohols of the fatty series has an appreciable influence on their heat of combustion.

Refrigerant Mixtures formed of Two Crystalline Salts.—A. Ditte.—The phenomena observed establish the possibility of forming refrigerating mixtures with two saline bodies, one of which retains much crystalline water, when the double decomposition resulting from their contact is effected without any marked liberation of heat.

Crystalline Hydrofluosilicic Acid.—M. Kessler.—The author has obtained a compound to which he assigns the formula $F_2SiFH+2HO$. It is probably the only known hydrated hydracid which crystallises at common temperatures.

Proportion of Carbonic Acid in the Air.—M. Marié Davy.—A reply to the second communication of M. Reiset. The author considers that many well-established facts are opposed to the theory of the uniform distribution of carbonic acid.

Preparation of Malonic Acid.—E. Bourgoin.—The author dissolves 100 grms. monochloracetic acid in double its weight of water, and saturates the solution with potassium bicarbonate, about 110 grms. He adds then 75 grs. pure potassium cyanide, and, after dissolving, heats carefully in the water-bath. To the liquid are added two vols. concentrated hydrochloric acid; the deposit of potassium chloride is removed, and the liquid is supersaturated with gaseous hydrochloric acid. The salts deposited are strained off through a plug of asbestos, and the mother-liquor which they hold back is displaced by a little hydrochloric acid. The washings are added to the acid solution which is evaporated at first at a boil and then on the water-bath. The residue, almost dry, is exhausted with ether, from which pure malonic acid is obtained on distillation or evaporation.

Preparation of Neutral Sulphuric Ether.—M. A. Villiers.—This neutral ether is prepared by distilling in a vacuum a mixture of sulphuric acid and absolute alcohol; about 200 grms. of the former with thrice its volume of the latter. The distillation should be exceedingly slow. The liquid which passes over is divided into two strata, of which the lower is the pure neutral colourless ether.

Presence in Soya hispida of a Substance Soluble in Alcohol and readily Convertible into Glucoose.—M. A. Levallois.—This substance is soluble in alcohol, does not readily reduce Fehling's liquid, and closely resembles glucose in its optical characters.

Justus Liebig's Annalen der Chemie,
Band 201, Heft 1.

Salts of Chloro-chromic Acid.—G. Prætorius.—The author has succeeded in obtaining barium and strontium chloro-chromates by using as a solvent glacial acetic acid instead of water. He has also formed and examined the chloro-chromates of magnesium, nickel and cobalt, zinc, sodium. He did not succeed in obtaining the cadmium salt.

Communications from the Laboratory of Würzburg University.—These consist of a memoir on butallyl-methyl-carbinol, by J. K. Crow; a memoir on diallyl-acetester and its derivatives, by C. Wolff; contributions to the history of methyl-crotonic acid, by Aug. Rücker; an account of diethyl-β-oxy-butyric acid, by H. Schnapp; and a paper on the reaction of zinc and iodallyl upon acetester and diethyl-acetester.

Communications from the University Laboratory of Halle.—These include an account of the behaviour of triacetonamin with iodethyl, by W. Heintz, and a paper on the existence of acetonin, by the same author. The conclusion arrived at is negative.

Molybdic Acichlorides.—W. Puttbach,—The author considers that six acichlorides of molybdenum are known, of which four are saturated.

Reimann's Färber Zeitung,
No. 14, 1880.

The Maritime Court of Bremerhaven has decided that the fire on board the *Mosel*, on October 3, 1879, was due to the spontaneous combustion of certain black silk yarn, which formed part of her cargo.

Dr. Göppelsrœder has resigned his Professorship at the Ecole de Chimie of Mulhouse.

No. 15, 1880.

This number contains nothing of general interest to our readers.

MISCELLANEOUS.

Agitation of Liquids.—For this purpose an india-rubber cover is constructed fitting air-tight to the working beaker and having two tubulures, through one of which a glass tube is passed to the bottom, thereby covering its lower end with the liquid, and its upper end is open to the air. The other tubulure is connected to an aspirator of some kind (in my laboratory a Bunsen's water pump is used with advantage), which, being put in motion, draws a stream of air bubbles through the liquid, thereby keeping it in a constant state of agitation. By means of this apparatus the precipitation of phosphoric acid, as ammonio-phosphate of magnesia, is complete after half an hour's agitation.—H. B. YARDLEY.

Washing Flask.—In the former communication I believe I may claim some originality, but in this present my desire is simply to draw the attention of brother chemists to the advantages of using an india-rubber ball with tubulure attached to the mouth-piece which is bent round to the side of the flask, so that by holding the neck of flask with the fingers, and pressing the ball with the thumb, the desired stream of liquid is obtained. The ball is provided with a small air hole, over which the thumb is placed, and which allows air to re-enter immediately on removal of the pressure. The stream of liquid can be kept up any length of time, and at a pressure varying at will and in any direction. I also always fit my wash flask with a movable jet by means of india-rubber tube. I may mention that Messrs. Townson and Mercer supply both these balls and the india-rubber covers previously described.—H. B. YARDLEY.

NOTES AND QUERIES.

Dissolving Shoddy.—A correspondent would be glad to know as to the best apparatus for dissolving shoddy for the manufacture of manure.—H.B.D.

Bright Red Writing Ink.—Will any of your learned correspondents kindly give me, through the medium of the CHEMICAL NEWS, a thorough good recipe for making a bright red writing ink.—J. SMITH

MEETINGS FOR THE WEEK.

MONDAY, 5th.—Royal Institution, 5. General Monthly Meeting.

TO CORRESPONDENTS.

Analyst.—We cannot give the information required. Probably an advertisement would get you what you want.

THE JOURNAL OF SCIENCE

for July (Price 1s. 6d.), includes—

The Evolution of Scientific Knowledge. By C. Lloyd Morgan.
Habits and Anatomy of the Honey-bearing Ant.. By C. Morris.
The "Laws of Emphasis and Symmetry." By J. W. Slater.
Instinct and Mind. By S. Billing.
Tuberculosis transmissible through the Meat and Milk o Animals affected with it.
Natural Science and Morality. By S. Tolver Preston.
Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

KING EDWARD'S SCHOOL, BIRMINGHAM.

The post of SCIENCE MASTER in the High School is vacant. Salary £250, with an annual increase up to £400.

Applications, accompanied by not more than three testimonials, should be sent in, not later than the 17th July, 1880, to the Secretary, King Edward's School, Birmingham, from whom further particulars may be obtained.

King Edward's School, 22nd June, 1880.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

SOUTH LONDON SCHOOL OF PHARMACY.

Special advantages are offered to Private Students during the Vacation commencing the end of July, in every branch of Practical Chemistry, as applied to Manufactures, Agricultural and Commercial Products, Water, Gas, Food, &c.

For terms, personal or by letter, W. Baxter, Secretary, Central Public Laboratory, Kennington Cross, S.E.

C. H. GIMINGHAM'S PATENT COMBINATION BLOWPIPE,

FOR AMATEUR & PROFESSIONAL GLASS-BLOWING, &c.

AS USED IN L. CASELLA'S WORKSHOPS.

The difficulties of Glass-Blowing are reduced to a minimum by this instrument. It combines the use of the large or small flame and large Bunsen flame, the changes from one to the other being made in less than one second.

SOLE MAKER—

L. CASELLA, 147, Holborn Bars, London, E.C.

To ANILINE and Other DYE MANUFACTURERS.—To be Sold by Tender, in lots, the LEASES of the Premises known as "The Star Chemical Works," Brentford, held for a term of forty years from Michaelmas, 1853, at a nominal rent of £28 per annum; and the "Star Chemical Works," Wandsworth Bridge Road, Fulham, occupying an area of 2a. 1r. 28p., and held for a term of ninety-nine years from 24th June, 1874, at a ground rent of £115 per annum (together with certain wharfage rights on the bank of the Thames, adjoining Wandsworth Bridge). Also, the Fixed and Loose PLANT, Stock and Effects, and Goodwill of the Business now being carried on at both the before mentioned premises.—Particulars, with Forms of Tender and conditions, may be had of Messrs. Munns and Longden, Solicitors, 8, Old Jewry, E.C; of Messrs. R. Mackay and Co., Public Accountants, 3, Lothbury, E.C.; and of Messrs. Frank Lewis and Co., Auctioneers, Valuers, &c., 95, Gresham Street, E.C.

TO OIL-MERCHANTS, DRUGGISTS, AND OTHERS.

To be Disposed of, by Private Treaty, the Old-established BUSINESS of Thomas Sneyd, of High Street, Walsall.

The Business has been established half a century, and, in addition to a Counter Trade, there is a good connection amongst the Manufacturers of the district.

For particulars apply to George Cotterell, Esq.. Solicitor, Walsall; or Messrs. Lomas Harrison and Starkey, Accountants, 14, Temple Street, Birmingham.

Wanted, a few Practical Lessons in the working of the Dynamo-Electric Machine, as applied to Chemistry and Metallurgy.—Apply, stating terms, to X. Y. Z., care of J. Woods, Great Queen Street, Westminster.

Established 1798.

ROBERT DAGLISH & CO.,

ENGINEERS, BOILER AND BRIDGE MAKERS, MILLWRIGHTS,

BRASS AND IRON FOUNDERS.

Manufacturers of every description of Condensing, or High-pressure Blowing, Pumping, Rolling, Winding, and Patent Steam-engines, of any required power, for Irrigating, Draining, Mining, Rolling Mills, or Water Works purposes, and Manufacturers of every description of Chemical, Colliery, Copper Ore, Gold Mining, Glass, and Rock-salt Machinery.

Black-ash Revolving Furnaces of the Most Approved Type.
Bessemer Steel-Rail Plant.
Compressing-Engines for Collieries, Iron Works, and Weldon's Patent Bleaching-Powder Process.
Caustic, Chlorate, Decomposing, Nitre, Nitro-Glycerine, Iodine Potash, Sulphur, Acid, and Oxalic Pans.
Gas Producers Patent for Heating and other Purposes.
Pyrites Burners for Irish, Norwegian, and Spanish Ores of Improved Construction.
Patent Rousing Machinery for Brewers.
Retorts, Acid, Gas, Iodine, Nitric, Nitre, Nitro-Glycerine and Vitriol Refining.
Steam Superheaters improved for Oil, Tar, and Resin Refining.
Steam Sulphur Melter.
Stills for Oil, Resin, and Tar.
Wheels, Bevel, Mitre, and Spur Moulded on the Shortest Notice by Patent Machinery.
Makers of Mactear's Patent Carbonating Furnace, Jones and Walsh's Patent Sulphate of Soda Furnace, Parnell and Simpson's Patent Causticiser, and Kynaston's Patent Alum Plant.

Lists sent on Application.

Photographs, Plans, and other information supplied on receipt of Order.

ST HELEN'S ENGINE, BOILER, AND BRIDGE WORKS AND FOUNDRY,

LANCASHIRE.

BISULPHIDE OF CARBON,

CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,

161 162 163, Palmerston Buildings, London, E.C

THOMAS ADKINS & CO.,

SMETHWICK,

NEAR BIRMINGHAM

Manufacturers of Specially Prepared Red Lead for Flint-Glass Making.

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

JESSE FISHER & SON,
Phœnix Chemical Works Ironbridge.

CHEMICAL & PHYSICAL APPARATUS,

BOTTLES, PURE CHEMICALS,

REAGENTS, STANDARD SOLUTIONS

And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

MOTTERSHEAD & CO.,

7, Exchange Street and 10, Half Moon Street,

MANCHESTER.

THE CHEMICAL NEWS.

Vol. XLII. No. 1076.

ON THE CRITICAL POINT OF MIXED VAPOURS.*

By JAMES DEWAR, M.A., F.R.S.,
Jacksonian Professor of Natural Experimental Philosophy in the University of Cambridge.

The following record of experiments regarding the behaviour of carbonic acid in presence of different vapours above the temperature of the critical points of the pure gas were undertaken to see if any optical discontinuity could be observed in such mixtures above this temperature. The object was intentionally a qualitative investigation, and thus many of the pressure observations have been taken from the metallic manometer.

The Liquefaction of Carbonic Acid in presence of other Bodies.

1. *Carbonic Acid and Bisulphide of Carbon.*—Carbonic acid liquefied in presence of bisulphide of carbon, at a pressure of 49 atmospheres and a temperature of 19° C., floated on the convex surface of the bisulphide, the line of separation being sharp and well defined, and remaining so.

At 35° C. liquid condensed on the surface of the bisulphide, in the same way, at a pressure of 78 atmospheres; at 40° C. it still appeared, at 85 atmospheres; at 55° C. there seemed to be a distinct appearance of two liquids, and at 58° C. there was still the same apparent separation under a pressure of 110 atmospheres. Observed at 47° C., and a pressure of 80 atmospheres, there was a distinct layer of a separate fluid on the surface of the bisulphide: the bisulphide surface, however, was not so well defined.

By keeping the temperature at 47° C., on increasing the pressure to 110 atmospheres, the upper surface of the liquid floating on the bisulphide almost entirely disappeared. By reducing the pressure again to 80 atmospheres the surface of demarcation disappeared; but in reducing the pressure another 5 atmospheres, the line of demarcation again appeared very sharply, and remained. A quick withdrawal to 58 atmospheres, and again gradually increasing the pressure to 85 atmospheres, did not make the liquid remain, but on reducing it again slowly to 80 atmospheres the definition became perfectly sharp.

2. *Carbonic Acid and Chloroform.*—Carbonic acid in presence of chloroform at 18° C. liquefied at 25 atmospheres, forming a distinct layer on the surface of the chloroform. On further compression the manometer rose rapidly to 50 atmospheres, at which pressure the two liquids mixed completely together, after being left for a few minutes. When the pressure was rapidly withdrawn distinct layers of what appeared to be carbonic acid were always formed, which, however, became rapidly dissolved in the chloroform on standing a few seconds.

At 33° C. liquid began to appear at a pressure of 35 atmospheres, and on increasing the pressure to 55 atmospheres it behaved in exactly the same way as at the lower temperatures, except that the layer was, if anything, more distinct and mixed more rapidly with the chloroform on standing.

At 55° C. a layer of liquid was still formed at a pressure of 50 atmospheres; at 67° C. it behaved in the same way, except that there was a smaller quantity of liquid formed, and the pressure rose to 85 atmospheres.

In every case it rapidly mixed with the chloroform when left for a few seconds.

3. *Carbonic Acid and Benzol.*—At 18° C. the carbonic acid commenced to liquefy at a pressure of 25 atmospheres, and at the moment of liquefaction the surface of the benzol became violently agitated, the carbonic acid falling through the benzol in an oily stream, and becoming completely mixed with it.

When by further condensation more liquid was formed the agitation almost entirely ceased, the liquid carbonic acid forming a distinct layer on the saturated benzol. On leaving this for about five minutes the line of demarcation disappeared, and the two liquids formed a perfectly homogeneous fluid.

On again increasing the pressure so as to get a layer of carbonic acid, and then releasing the pressure gradually, the liquid carbonic acid on the surface first fell in oily streams through the saturated benzol; but when all this had disappeared the carbonic acid then commenced to boil from the bottom of the benzol, and continued to do so until it was again entirely vapourised.

At 35° C. liquid commenced to appear at 35 atmospheres, forming a distinct layer on the surface of the benzol, which was not in the least agitated. On further compression the liquid layer increased in volume, but no oily streams were seen to fall through the benzol; and on leaving it for about ten minutes the layer of liquid was almost just as distinct, showing that it was not nearly so soluble in the benzol at this temperature.

On the pressure being now reduced the liquid quietly evaporated away from the surface; but when all this had disappeared carbonic acid commenced to boil out of the benzol, showing that it had dissolved a considerable amount.

At 52° C. the liquid appeared at 60 atmospheres, forming a layer which mixed with the benzol on standing; and at 70° C. and 85 atmospheres a distinct layer was also formed, which, however, rapidly mixed with the benzol.

4. *Carbonic Acid and Ether.*—A tube was filled with carbonic acid, and a little ether introduced. At 20° C., and at a pressure of 20 atmospheres, the carbonic acid liquefied and fell through the ether, mixing with it in all proportions.

At 42° C. liquid was condensed on the surface of the ether at a pressure of 55 atmospheres, forming a distinct layer; the upper surface of the ether was, however, kept in continual oscillation, from the apparent solution of the carbonic acid in it. No currents due to the falling of the carbonic acid through the ether were visible. At 68° C., and a pressure of 110 atmospheres, a perfectly separate layer of fluid was found on the surface of the ether, and no currents were descending through the ether.

5. *Carbonic Acid and Nitrous Oxide.*—When a tube was filled with equal volumes of carbonic acid and nitrous oxide, and the gases were liquefied, they mixed together in all proportions, no difference at all being perceptible; but when the pressure was suddenly withdrawn the one gas boiled before the other, and for a few seconds a distinct line of separation was seen.

Liquefaction of Carbonic Acid with Trichloride of Phosphorus.

At 16·20° C., and 42·95 atmospheres pressure, the carbonic acid commenced to condense on the sides before the trichloride of phosphorus came in sight, and when the latter was visible a slight indistinct layer of CO_2 was seen on the surface, only distinguishable by the different refractive indices of the two liquids, there being no sharp line of demarcation. On standing a few minutes the liquids became quite homogeneous. On increasing the pressure more carbonic acid was condensed, forming a more or less distinct layer on the surface of the trichloride of phosphorus. This, however, rapidly disappeared on standing. On releasing the pressure the carbonic acid boiled first on the surface, but afterwards through the liquid, the trichloride of phosphorus at the same time falling in heavy striæ to the bottom.

* A Paper read before the Royal Society, June 17, 1880.

At 23° C. the carbonic acid appeared to liquefy at 46·91 atmospheres, exactly the same appearances taking place as at 16° C.

At 30° C. the carbonic acid liquefied at 49·94 atmospheres, forming a rather more distinct layer, and not mixing so readily. On increasing the pressure to 90 atmospheres the surface of the carbonic acid disappeared, it being near its critical point, the top part of the tube being filled with a homogeneous mass. The trichloride of phosphorus could also not be distinguished on the surface of the mercury, its upper surface being entirely mixed up with the carbonic acid, the whole space above the mercury forming one homogeneous mass.

On releasing the pressure a cloud first appeared, and then the surface of the carbonic acid became visible; it boiled away first from the surface, and afterwards through the trichloride of phosphorus.

At 33° C.	liquid carb. acid	appeared at	50·84	atmos.
„ 40	„	„	56·88	„
„ 50	„	„	66·53	„

At all the temperatures above 30° C. the appearances were the same, except that as the temperature increased the quantity of carbonic acid liquefied diminished, and it took a great pressure to make the surface of the trichloride of phosphorus disappear.

The following are pressures taken with a smaller quantity of carbonic acid and trichloride in the tube, and were read off when the surface of the trichloride was first agitated, thus showing that the carbonic acid had commenced to condense:—

At 10·5° C.	22·70	atmospheres.
„ 16·5 „	24·70	„
„ 22·8 „	32·18	„
„ 30·0 „	33·88	„
„ 40·0 „	36·36	„
„ 50·0 „	49·67	„
„ 70.0 „	76·61	„

Liquefaction of Carbonic Acid with Tetrachloride of Carbon.

The quantity of tetrachloride of carbon was a little less than the volume of the carbonic acid when liquefied.

At 12·8 C. the surface of the liquid appeared agitated as soon as it appeared in sight, and on increasing the pressure, a distinct layer of carbonic acid was formed on the surface of the tetrachloride; on increasing the pressure a still more distinct layer was formed, which, however, on standing, rapidly commenced to dissolve in the tetrachloride, and in about ten minutes it was perfectly homogeneous.

At 21·4° C. the surface of the tetrachloride appeared agitated when it came in sight, a layer of liquid being formed on increasing the pressure, as at 12° C.

At 30° C. liquid was also formed, which, however, rapidly diffused into the tetrachloride of carbon.

At 40° C. the liquid also appeared agitated, and on increasing the pressure rapidly a small quantity of fluid was condensed, which, however, rapidly disappeared in the tetrachloride.

At 52° C. the liquid again became agitated, and on increasing the pressure a distinct layer of liquid was formed.

The same took place at 58° C.

Liquefaction of Carbonic Acid and Chloride of Methyl.

When chloride of methyl was compressed in a tube by itself it became liquid before the pressure could be registered, and must have been below 10 atmospheres.

When compressed with about twice its volume of carbonic acid, at 13·5° C.,—the chloride of methyl, of course, liquefied first,—and about 27·67 atmospheres, its surface became agitated, showing that the carbonic acid had commenced to liquefy; but the exact point was difficult to ascertain, as it dissolved so very rapidly in the chloride of methyl.

At 20·05° C. this point appeared to be at 28·57 atmospheres.

At 30° C. some liquid was also condensed, but the pressure at commencement of liquefaction could not be taken, as it mixed so rapidly with the chloride of methyl.

That more liquid was in reality condensed was seen by the lengthening of the liquid column, and by its boiling out of the chloride of methyl when the pressure was reduced.

At 40° C. exactly the same took place.

Carbonic Acid and Acetylene.

About equal volumes of these gases were compressed together; they liquefied and mixed completely at all the temperatures given below, and no appearance of two different gases being liquefied was visible, except that the liquid was strongly agitated during condensation. The pressure at the point of liquefaction was, as in the former cases, lower than either of the gases liquefied by themselves. Thus—

At 13·5° C.	25·23	atmospheres.
„ 21·0 „	26·8	„
„ 26·8 „	34·1	„
„ 31·9 „	40·26	„
„ 39·0 „	55·3	„
„ 41·0 „	75·32	„

The critical point was, on the other hand, heightened as usual, being 41° C.; that of carbonic acid being 31° C., and of acetylene 37° C.

Carbonic Acid and Hydrochloric Acid Gases.

A mixture of equal volumes of these gases was filled into a tube, and the liquefied gases mixed completely together at all temperatures below the critical point, which was 36° C., forming a perfectly homogeneous fluid; in fact, it was impossible to tell that two different gases were present, as even at the point of liquefaction no difference was discernible.

The following are the pressures at which the mixture liquefied:—

At 0·0° C.	36·0	atmospheres.
„ 5·0 „	39·0	„
„ 8·0 „	43·8	„
„ 10·1 „	48·2	„
„ 18·5 „	59·0	„
„ 34·0 „	83·0	„
„ 35·5 „	90·0	„

Carbonic Acid and Bromine.

A tube filled with a mixture of carbonic acid and bromine vapour, by passing dry carbonic acid through a tube containing dry bromine before entering the liquefying tube. A little strong sulphuric acid was also introduced to protect the mercury. On compressing this mixture at 11·5° C. the sulphuric acid appeared in sight with a layer of liquid at 50 atmospheres, the liquid having a decidedly red colour.

On increasing the pressure the liquid became more highly coloured, while a little pure bromine liquid fell through the carbonic acid liquid, remaining a short time on the surface of the sulphuric acid, through which a globule also sank.

As this tube was spoiled through the amount of bromine which fell through the sulphuric acid, another was put up in the same way, and heated at once to about 40° C., before compressing the mixture.

On the sulphuric coming in sight a small layer of bromine was seen on the surface, which was surmounted by a layer of darkish red liquid, about ½ inch long. The pressure was about 60 atmospheres.

On increasing the pressure to 90 atmospheres the upper

liquid increased a good deal in quantity, and then disappeared entirely, but immediately reappeared on reducing the pressure a few atmospheres, and remained permanently.

Carbonic Acid and Camphor.

Some small pieces of camphor were placed in the capillary part of an ordinary Cailletet tube, near the end, and fused so as to adhere to the sides. The tube was then filled with carbonic acid gas.

On compressing this mixture in the pump, at 12° C., the camphor was seen to melt and run down the sides of the tube before the mercury appeared in sight. (In this experiment it was not observed whether liquid carbonic acid had commenced to form in the tube, and thus dissolve the camphor, or whether the latter was dissolved in the gas.) On continuing the pressure, so as to almost fill the tube with liquid, two distinct layers of liquid were seen, the lower one being slightly cloudy, containing the dissolved camphor, the upper liquid being perfectly clear. On compressing at different temperatures up to 55° C. the lower cloudy liquid was always present, the upper layer diminishing gradually in quantity as the temperature rose; but at 40° C. there was still a slight layer on increasing the pressure to about 125 atmospheres.

On withdrawing the pressure very suddenly, when the tube was full of liquid at 50°, the sides of the tube became coated with crystallised camphor, which rapidly dissolved again on increasing the pressure. After doing this several times a very small quantity of camphor was seen to crystallise out, and in taking down the tube the most of it was found to have crystallised out in the top part of the reservoir near the joining with the capillary part, thus allowing the mercury to get past it on again increasing the pressure.

Carbonic Acid and Camphor (second tube).

Another tube was filled in the same way as the last (a rather larger quantity of camphor being placed in the capillary part), with this exception, that the carbonic acid, after being dried, was passed through a tube containing fragments of solid camphor, which were gently heated, so as to fill the tube with carbonic acid gas saturated with the vapour of camphor.

When this tube was compressed in the pump at a temperature of 15° C., and when the pressure reached 27·7 atmospheres, the camphor was seen to gradually melt and run down the sides of the tubes before the mercury appeared in sight.

On increasing the pressure to 37 atmospheres the mercury appeared in sight, with about ¼ of an inch of a turbid liquid on the surface. On still further increasing the pressure two distinct layers of fluid were formed, which, however, became quite homogeneous after a short time. On mixing them up by a rapid decrease and increase of pressure, the two fluids soon mix. At 28° C. two layers of liquid were distinctly visible at 65 atmospheres, the lower layer being visible as soon as the mercury appeared in sight.

At 35° C. carbonic acid was condensed on the surface of the lower liquid at 80 atmospheres, but when the pressure was increased to 100 atmospheres the surface of the carbonic acid became undefined.

At 45° C. carbonic acid is seen to condense on the sides of the tube at a pressure of 100 atmospheres, running down and forming a slight layer on the surface of the camphor liquor, which, however, disappears on still further increasing the pressure.

When the temperature was 42·5°, and the pressure was suddenly reduced, the inside of the tube became covered with crystals of camphor. On now increasing the pressure very carefully the camphor was seen to melt or liquefy and run down the sides of the tube at a pressure of 37·6 atmospheres; and this pressure scarcely increased at all until all the camphor was thus liquefied.

A diminution of the pressure by two or three atmospheres was sufficient to bring out the crystals of camphor.

At 60° C. the lower layer of liquid still remained, and on increasing the pressure to 100 atmospheres there was an appearance of liquefaction of carbonic acid on the surface.

Carbonic Acid, Air, and Camphor (third tube).

A quantity of camphor was placed in the capillary part of a tube as before, which was afterwards filled with a mixture of 4 volumes of carbonic acid, saturated with camphor vapour, and 1 volume of air.

The tube was surrounded with water at 25° C., so as to be far above the critical point of the carbonic acid and air mixture, and on now increasing the pressure the camphor liquefied and ran down the sides of the tube as before. At 50° C. a quantity of liquid, about ¼ inch long, appeared on the surface of the mercury when it came in sight, the pressure being now 65 atmospheres.

On leaving the pressure the same, the mercury being just in sight, and increasing the temperature gradually to 60° C., the inside of the tube above the liquid became covered with camphor crystals, which on increasing the pressure another 5 atmospheres (viz., to 70 atmospheres) again dissolves.

At 65° C., the pressure standing at 70 atmospheres and the mercury and liquid being in sight, on reducing the pressure to 65 atmospheres the camphor crystals separated out, being again suddenly dissolved on again increasing the pressure to 73 atmospheres. On now rapidly letting down the temperature to 15° C. a white mass of camphor separated out from the liquid, which again dissolved on a slight increase of pressure, although it could not be again separated out by diminishing it. These actions may be due to super-saturation and the effect of pressure in aiding solubility when contraction takes place during solution.

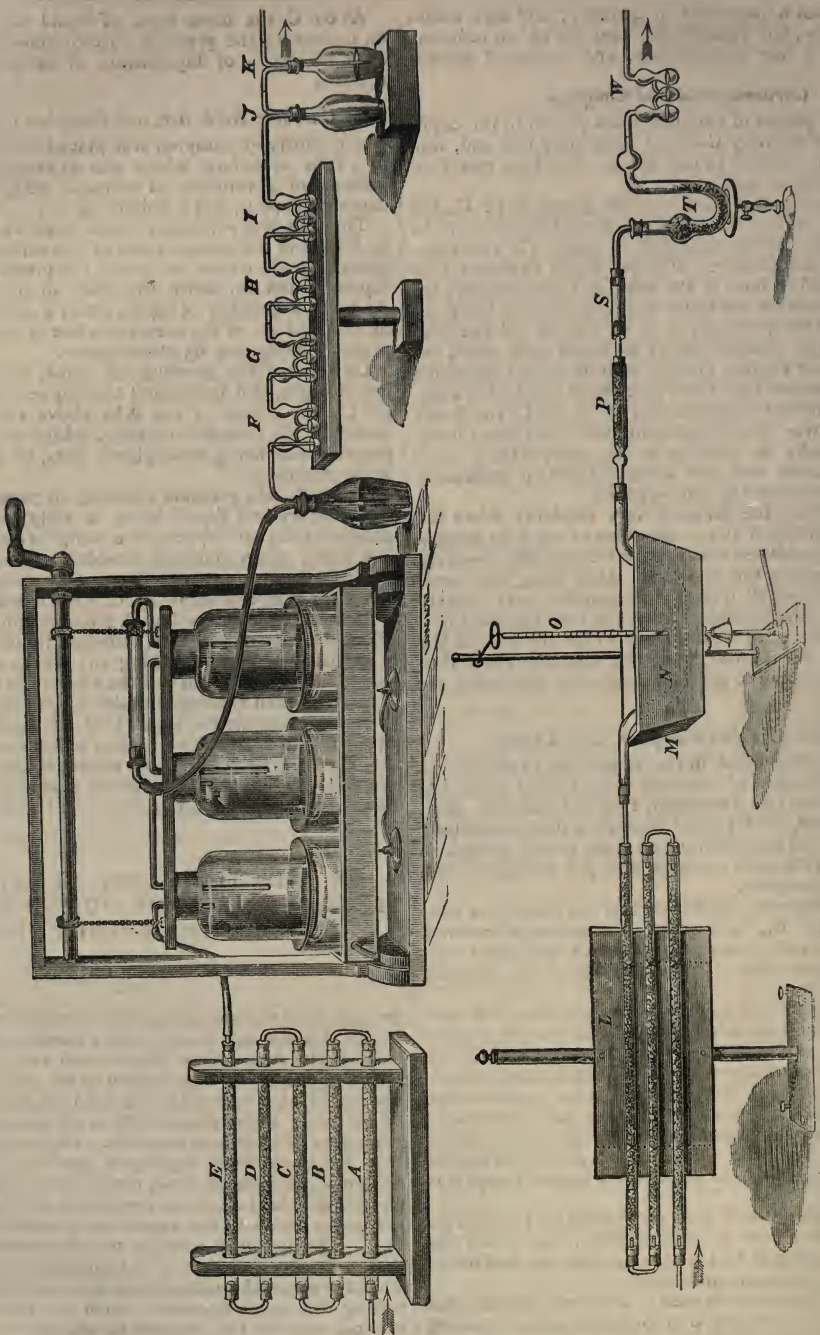
These experiments show that carbonic acid at high pressures, in presence of various substances, acts as if it produced a series of unstable chemical compounds, which are decomposed and re-composed according to the conditions of temperature and pressure in the medium.

ON THE FORMATION OF HYDROGEN PEROXIDE AND OZONE DURING THE ACTION OF MOIST PHOSPHORUS UPON AIR.

By Professor A. R. LEEDS.

IN various earlier memoirs, and especially in one published in the *Annalen der Chemie und Pharmacie* (200, 286) entitled "On Ammonium Nitrile, and on the By-products obtained during the Ozonisation of the Air by Moist Phosphorus," I have referred to the fact that the ozone obtained on oxidising moist phosphorus in air always contains an admixture of hydrogen peroxide. I have showed, further, that the quantity of hydrogen peroxide evolved under known conditions of time, temperature, surface of phosphorus, &c., bear a certain proportion to that of the ozone produced, which in the experiments quoted, amounted to $\frac{1}{100}$. The hydrogen peroxide was determined by titration on the assumption that it is completely absorbed by the washing-water, the ozone being first expelled by concentrating the washing-water down to two-thirds of its original volume, the absence of nitrious acid being then ascertained by Griess's method with meta-diamido-benzol, and the quantity of hydrogen peroxide which has been contained in the current of ozonised air being determined in the residue. The purpose of this paper is to show, by a method totally different from that which I formerly employed—

1. That both hydrogen peroxide and ozone are formed during the action of air upon moist phosphorus.
2. That in this great dilution they are not perfectly decomposed even after a prolonged state of mixture.
3. That if the current of ozonised air is conducted through a tube heated to various temperatures, the



quantity of water obtained by the decomposition of the hydrogen peroxide increases with the rise of the temperature.

4. That, under these circumstances, the proportion of ozone regularly decreases, and that no ozone reaction is to be obtained above 200°.

5. That if, after reaching this point, instead of the neutral solution of potassium iodide employed for the titration of ozone, and perfectly free from potassium iodate, there is used a solution mixed with sulphuric acid, it undergoes a slow decomposition, due not to ozone, which has been completely decomposed at a temperature of 200°, but to the spontaneous decomposition by oxygen of an acidified solution of potassium iodide.

The chief points of the new method of examination were :—

1. Filtered and purified air was brought in contact with a great surface of phosphorus partially immersed in distilled water, free from compounds of ammonium and nitrious acid, and maintained during the ex-

periment at the temperature most favourable for the formation of ozone (24—25°).

2. The hydrogen peroxide is removed as far as possible from the ozonised air by means of a sufficient series of washing-bottles.
3. The current of air, after passing these bottles, must be freed from every trace of water.
4. Both the hydrogen peroxide and the ozone are then decomposed by a gradual increase of temperature.
5. Lastly, any ozone which may still exist after the action of the heat is titrated and the water which has been formed is weighed.

This chain of thought is realised in the apparatus represented by the accompanying wood-cut. The air is here filtered through a series of purifiers, of which A contains cotton-wool, which in B, C, D, and E are glass globules, those in B and C being steeped in soda-lye and those in D and E in sulphuric acid. After the air has been ozonised in the phosphor-ozonator, it is drawn by the connecting tube into the first washing-bottle and thence into the four Geissler bulb apparatus, F, G, H, I, which all, like the washing-bottle, are filled with water. It passes then first through the empty washing-bottle, J, then through a bottle filled with sulphuric acid, K, and the three drying tubes, L, which for the length of 2·5 metres contain glass beads steeped in sulphuric acid.

From the drying-tubes the ozonised air passes into the U-tube, N, placed in the oil-bath, M. Its middle part contains for the length of 0·25 metre asbestos which has been previously ignited in order to offer the largest possible heated surface to the stream of air. Next follows a weighed drying-tube, P, charged with sulphuric acid; another of U-shape, T for safety, and lastly a bulb apparatus, W, filled with neutral potassium iodide. Between P and T, there is introduced for convenience, an empty tube, S, closed with corks at each end.

The following experiments were conducted under circumstances as identical as possible, twelve litres of air being drawn through the apparatus in every two hours, whilst the ozonator was heated to 24°. The increase of weight of the drying-tube, P, corresponds to the weight of the water formed by the decomposition of the hydrogen peroxide when heated to different temperatures. The numbers obtained are shown in the following table:—

	Expt.	Temp.	Water.	Hydrogen Peroxide.	Ozone.
		°	Grm.	Grm.	
Series I.	I.	100	0·0015	0·0028	not determined
	II.	50	0·0010	0·0019	,,
	III.	24	0·0000	0·0000	,,
Series II.	IV.	200	0·0010	0·0019	0·0000
	V.	200	0·0011	0·0020	0·0000
	VI.	150	0·0002	0·0004	0·0011
Series III.	VI.	100	0·0015	0·0028	0·0013
	VII.	50	0·0003	0·0006	0·0044
	IX.	21	0·0000	0·0000	0·0037
Series IV.	X.	200	0·0018	0·0034	0·0000
	XI.	100	0·0002	0·0004	0·0011
	XII.	22	0·0000	0·0000	0·0051

These results seem to me to prove the correctness of the first four propositions; they show that both hydrogen peroxide and ozone are formed, and that on heating the ozonised air the quantity of water thus found increases regularly, whilst that of the ozone as regularly decreases, till at 200° all the hydrogen peroxide is transformed into water and all the ozone into ordinary oxygen.

After the conclusion of the twelfth experiment the intermediate apparatus, dryers, &c., were removed, and the bulb-apparatus, W, containing potassium iodide, was placed in direct connection with the washing-bottle, F. On drawing through it the same quantity of ozonised air, in the same time and under the same conditions, there were obtained 7·94 m.grms. instead of the 5·1 m.grms. obtained in experiment 12. The difference of 2·84 m.grms., = 36 per cent of the quantity of ozone originally formed, corresponds to the loss due to the decomposition of the hydrogen peroxide simultaneously present.

Thus proposition 2 is confirmed, and we see that hydrogen peroxide and ozone in a dilute condition can exist together without great loss,* but that the quantity of the hydrogen peroxide existing in the ozonised gas bears a not inconsiderable proportion to that of the ozone itself. If we neglect for the moment the trifling quantities of hydrogen peroxide retained in the washing water, its proportion to the ozone is as 1 : 3.

The quantities of hydrogen peroxide absorbed by the washing water during the entire series of experiments were as follows:—The bulb-apparatus, F, containing 47 c.c. of water, after evaporation down to two-thirds of its original bulk in order to expel any dissolved ozone, yielded 0·2 m.grm H_2O_2; G, containing 26 c.c., gave after similar treatment a reaction indicating 0·08 m.grm. H_2O_2; H yielded 0·01 m.grm. The entire quantity found in all the washing waters was 0·29 m.grm. H_2O_2. Further, as hydrogen peroxide in a so dilute gaseous condition is not entirely without influence upon a pure neutral solution of hydrogen, the values given in the table are slightly too high.

Finally, in order to decide whether the supposition 5 is correct, the experiment was repeated with the tube N heated to 200°. I will again mention that in all earlier experiments at this temperature a neutral solution of iodide was employed, and no liberation of iodine could be observed, whilst in this experiment a decomposition took place corresponding to 0·2 m.grm. ozone. Herewith it is proved that in a current of air from which every trace of hydrogen peroxide and ozone have been removed by a strong heat, a seeming ozone reaction is produced by the oxygen present, in the case that the potassium iodide solution used for titration is acidulated.*—*Berichte der Deutschen Chem. Gesellschaft.*

* This point has been established by Schöne in opposition to the statements of Schönbein. *Journ. Prakt. Chemie*, 76, 130, and *Ann. Chem Pharmacie*, 196, 249.

ON WELDON MUD.

By G. LUNGE.

DR. POST has in the CHEMICAL NEWS, vol. xli., p. 276 undertaken to state the results of a discussion between us concerning the composition and analysis of Weldon mud, which took place in *Dingler's Journal*; but he has supplied little more than his own part of it. It would be incumbent upon me now to state what, in my opinion, controverts Dr. Post's position, if this question had not been treated very fully by Mr. Weldon himself in a paper read before the Newcastle Chemical Society. I shall, therefore, content myself with a few remarks, which will, however, practically deal with the whole of Dr. Post's paper.

Dr. Post seems to object to my defending the analytical processes described by me some years ago in *Dingler's Journal*, which are those of Mr. Weldon, modified in a few less essential points, on the ground that he (Dr. Post) had never used these processes for Weldon mud, nor expressed any opinion about their value. But this is immaterial, since he has employed one of these processes, viz., the testing for MnO_2, for the product recovered by his own plan and declared it to be incorrect, and since his assertions about the freedom of Weldon mud from lime necessarily carry the inference that the usual testing for base is also altogether wrong. The latter would refer both to Mr. Weldon's prescription and to my own modification of it. In the former case he tried only my plan (which substitutes permanganate for bichromate), and asserted to have found an enormous difference between

* See *Phil Mag.*, April, 1879; *Journal Amer. Chem. Soc.*, i., 18.

the results of this and of Bunsen's iodine test. In order to dispel any confusion that might arise on these points, I felt myself called upon to re-investigate those methods, and I found that they were perfectly correct, Dr. Post's assertions notwithstanding. This forms the subject of my former paper, in which I also showed that the presence of HCl, if it made any difference in the permanganate iron test, would have just the opposite effect ascribed to it by Dr. Post. I do not feel that I need any further justification for the course which I have taken.

My objection that the great bulk of Dr. Post's work on Weldon mud is quite worthless for deciding the question of the presence of calcium and other manganites therein, because he worked on a substance changed by contact with an enormous amount of water, is practically acknowledged to be valid by Dr. Post himself, who now relies upon one single analysis of unwashed Weldon mud to prove his case. His attempt to turn even my own analysis against myself has been fully answered by me in *Dingler's Journal*. For the reason given above I shall refrain from repeating my own arguments, as well as from going into the question whether I believe Dr. Post's analytical methods to have been inexact, or their execution faulty, or both. I shall simply put the whole case broadly as it stands apart from the question of the accuracy of his or my individual assertions.

If Dr. Post's work is correct, that is, if Weldon mud, in spite of the large excess of lime present, contains no calcium other than as chloride, carbonate, and sulphate, it cannot, *a fortiori*, contain a "manganite" of calcium; consequently the compound MnO_2 (or its polymer, which is immaterial to the question at issue) does not possess any acid properties. Dr. Post tries to "guard himself against this conclusion in advance," but I do not see how he can reconcile his analyses with the contrary opinion. Now, if that is so, Dr. Post's *work* (whatever his *theory* may be) is contradicted by the unanimous testimony of the large number of chemists who have investigated the behaviour of manganese dioxide during the last few years, of whom I shall only name Gorgen, Pattinson, Wright and Luff, Beilstein and Jawein, Volhard, Stingl and Morawski, not to speak of Mr. Weldon himself, who has probably worked more on this subject than all of them put together, although he has published comparatively little of his results. All these chemists agree that MnO_2 carries down basic oxides of all kinds, MnO, ZnO, CaO, K_2O, &c.; it even decomposes alkaline chlorides and nitrates in this way, setting free HCl and NO_3H. Some of them describe definite compounds, in which MnO_2 plays the part of an acid. In the recovery of MnO_2 by Weldon's process *all* conditions are present which determine MnO_2 in its formation to carry down, not merely MnO, but CaO, MgO, &c., in a combined state, whether we call it a "manganite" or not. Shall we believe that all these chemists are mistaken, and that Dr. Post is right in denying calcium to be an *essential* constituent of Weldon mud, which it cannot help being if the acid properties of MnO_2 are granted? But if this assumption is declined, then Dr. Post's *work* cannot be correct.

Can we believe, then, that really Weldon mud occurs in practice with a base below 0·5, because Dr. Post asserts in *one* case to have found 0·46, not by direct estimation of the base, but by a most complicated analysis? Since I asserted, both in English and German periodicals, that "to my knowledge" such muds do not occur in practice, and since Dr. Post put forward his own and only analysis in attempted refutation of my assertion, several months have elapsed, but not a single case has been made known by an independent observer which would contradict me, nor has Dr. Post evidently been able to find such a case apart from his own analysis. Now, there exist, without exaggeration, on the one hand in factories, hundreds of thousands of estimations of base, not one of which is known to show below 0·5; on the other hand there is *one* indirect estimation of the base by a chemist whose analytical work is otherwise irreconcileable with the evidence of all other chemists in the field. Whether that is enough to prove the practicability of obtaining less than 0·5 base, the reader may judge for himself. But even if some cases of lower base were proved to occur by less doubtful evidence, this would not by itself disprove the main point, viz., that Weldon mud contains CaO chemically combined with MnO_2.

The question, What becomes of the excess of lime in the Weldon process? has long since been fully dealt with by Mr. Weldon, of whose work Dr. Post seems to know very little. How imperfect is his acquaintance with the Weldon process is best shown by his claim (*Berlin Ber.*, 1879, p. 1458) to have discovered the presence of CO_2 in Weldon mud, which, in his opinion, had been overlooked by everybody up to that time. But not merely had every practical man known all about that, but I had actually, many years ago, in that publication which has formed the basis of an accurate knowledge of the Weldon process in Germany (*Dingler's Journal*, ccxv., p. 149), mentioned the presence of CO_2 in Weldon mud, and described the means adopted by some manufacturers to overcome this drawback.

Zürich, June 25, 1880.

THE ANALYSIS OF PYRITES BY THE GRAVI-VOLUMETRIC METHOD.

By M. A. HOUZEAU.

ONE grammme of the powdered ore is attacked with a mixture of 4 parts pure potassium nitrate and 3 parts sodium carbonate, likewise pure. The saline mass is dissolved in hot water, and the ferric oxide is filtered from the alkaline sulphate. The washing waters are added to the filtrate, and after cooling it is made up with distilled water to half a litre. A portion is then taken—10 c.c—and acidulated with a few drops of pure acetic acid, and the sulphuric acid is rapidly determined, as the author has elsewhere indicated for selinitic waters by making use of a standard solution of barium chloride, applied by the aid of the *gravi-volumeter* in place of the ordinary burette, the use of which, in such determinations, yields merely erroneous results. In the gravi-volumeter the weight of the standard solution shows the quantity of the reagent which has been used. But each drop of the barytic liquid delivered by the gravi-volumeter weighs at the temperature of 15° exactly 0·050 grm. The author then proceeds to show that series of determinations made by this process, vary less than do series made by the ordinary gravimetric method. After oxidising a specimen of pyrites with nitric acid and precipitating with barium chloride, he found the weight of the precipitate 0·343 grm. = 47·1 per cent sulphur. By three successive fusions with pure sodium carbonate and re-precipitations with barium chloride, the weight of the barium sulphate was reduced to 0·331 grm., representing 45·4 per cent of sulphur. In thus purifying barium sulphate by fusion it is necessary to employ wood charcoal as a source of heat, since coal-gas besides reducing a part of the sulphate furnishes sulphur, which is ultimately transformed in the crucible into sodium sulphate. In fine, for the exact determination of the sulphur in pyrites by the gravimetric method, several days are required, whilst after the samples are dissolved two determinations can be effected by the gravi-volumetric method in half an hour.—*Comptes Rendus.*

Aromatic Arsenical Compounds.—A. Michaelis and W. la Coste.—This treatise is a continuation of the researches of the authors on the combinations of the elements of the nitrogen group with the radicles of the aromatic series. From its great extent it is incapable of useful abstraction.—*Liebig's Annalen.*

PROCEEDINGS OF SOCIETIES.

THE AMERICAN CHEMICAL SOCIETY.

The May Conversazione of the Society was held at University Building, Washington Square, New York, on Thursday evening, May 20th, 1880. Among a number of very interesting exhibits the following are worthy of notice:—

Dr. Arno Behr exhibited a solution of copper sulphate containing an abundant growth of filamentous Fungi. This solution contained about 3½ per cent of ordinary pure copper sulphate, and the fact that copper salts are usually considered inimical to living organisms makes this exhibit interesting.

The same gentleman also exhibited a remarkable leather-like deposit found in a dust-flue of a sugar-refinery. It was made up of layers of filamentous tissue, and was probably formed by the growth of Fungi which exude a kind of glue-like material that cements the various layers together. This material was quite tough, like thin leather, and of a nut-brown colour. It often occurs covering a surface several feet in area, having the appearance of a coat of paint.

Some black scale from the interior of the retorts used in making bone-black was also exhibited by Dr. Behr. This material appears to eat into, and finally through, the retorts, making it necessary to replace them occasionally. It consists of some carbon, together with sulphide of iron, and appears to act upon the metal of the retorts by giving up its sulphur to the metallic iron, becoming reduced to a lower sulphide, which in turn acquires new sulphur from the sulphates in the bones burnt and also from the albumen which they contain.

A filter-press, of Wegelin and Hübner, for use in laboratory experiments, was also shown and explained by Dr. Behr. It consisted of a filter-press, with the usual frames for paper, cloth, or wire, and a monte-jus attachment. The monte-jus is simply an air-tight vessel, into which the liquid to be filtered is placed, and thence forced through the filter diaphragms by means of compressed air. The air is compressed upon the surface of the liquid in the monte-jus, and a tube from the bottom of the vessel delivers the fluid with its suspended matter to the filter frame. The pump for compressing the air is attached to the side of the monte-jus, and a gauge dial shows the pressure in the interior of the apparatus.

In answer to a question as to the kind of industries in which these presses were used, it was stated that they could be adapted to every conceivable want, and that they were now being used in the United States to filter beer.

Dr. Behr said that the advantage of this press with the monte-jus attachment was that the flow of liquid through the press was steady, while in using the simple pump press without the monte-jus attachment the intermittent action of the pump often caused a turbidity in the filtrate.

A specimen of the new metal Gallium, made by the discoverer, Lecoq de Boisbaudran, was exhibited by Dr. C. F. Chandler, of Columbia College. It was only a few millimetres in area, but was interesting as the first specimen seen in this country. It is a hard white metal, melting at the heat of the hand.

Dr. Chandler also exhibited a specimen of naphthaline taken from the main leading from the retorts to the gasometer of the Municipal Gas-Light Company, of New York. This company makes gas by passing steam over red-hot anthracite coal, and the resulting mixture of carbonic oxide and hydrogen is carburetted by passing it through petroleum naphtha, and then through red-hot retorts again. The naphthaline deposit exhibited shows the conversion of the hydrocarbons of the paraffin series into those of the aromatic series by heat.

Prof. A. R. Leeds, of the Stevens Institute, exhibited a beautiful piece of glass-work by Prof. Richards, of the Massachusetts Institute of Technology. It consisted of a very ingenious regulator, to maintain a constant temperature in a hot-air oven for laboratories. It was made entirely of glass, and much admired for its fine finish. Dr. Leeds said that this apparatus worked very satisfactorily.—Arthur H. Elliott, *Recording Secretary.*

NOTICES OF BOOKS.

A Theoretical and Practical Treatise on the Manufacture of Sulphuric Acid and Alkali, with the Collateral Branches. By G. Lunge, Ph.D., F.C.S., Professor of Technical Chemistry at the Federal Polytechnic School, Zürich (formerly Manager of the Tyne Alkali Works, South Shields). Vol. II. London: Van Voorst.

In introducing to our readers this second volume of Dr. Lunge's great work we are happy to say that it shows no falling off in point of value and interest. It is devoted to the alkali manufacture according to Leblanc's process, from the manufacture of salt-cake to the utilisation of the vat-waste. A third volume is announced, giving an account of the Solvay process, the manufacture of soda from cryolite, the preparation of bleaching-lime and chlorate of potash, followed by an estimate of the cost of plant for every department of an alkali works.

The account of sodium sulphate—or, as it technically called. salt-cake—commences with a very minute description of its composition and properties, especially its solubility, the methods used for its analysis, and the processes for manufacture. It is remarked that its production in cylinders as a by-product from the manufacture of superior hydrochloric acid has almost entirely ceased—a statement with which we can scarcely agree, since most of the hydrochloric acid used in the preparation of dyers' spirits is still obtained in this manner, that from the alkali works (technically known as *tower* salts) being often found untrustworthy. We notice, also, that the manufacture of aluminium chloride from the reaction of common salt and alum is spoken of as a process actually in use and yielding crystalline sodium sulphate as a secondary product. It is remarked that the manufacturers of Glauber's salt at Stassfurt prepare it only in frosty weather, as the use of ice-making machines seemed too expensive.

The bulk of the salt-cake in the market is of course obtained by the decomposition of common salt, either on the ordinary Leblanc process or by the action of sulphurous acid and atmospheric air—Hargreaves and Robinson's method—or by heating the salt with metallic sulphides, as proposed by Berzelius as far back as 1836, and known even in the last century. It is a curious fact that the French Commission of 1792 in their official report pronounced this process superior to that of Leblanc.

Concerning the present extent of the production of salt-cake it is stated that whilst in 1869 the quantity of salt decomposed in England was 326,000 tons, in 1676 (doubtless 1876), it had risen, for the United Kingdom, to 647,000 tons. Dr. Lunge does not agree with the commonly-received theory of the decomposition of the salt, according to which only 50 per cent of the total hydrochloric acid ought to be given off in the decomposing-pan. In practice the amount eliminated is 66 to 70 per cent, though the heat reached never even approaches redness.

In the manufacture of salt-cake the form or condition of the salt is a matter of importance. Neither rock-salt nor the salt obtained by evaporation at a boiling heat, and known as butter-salt, is suitable, but a coarse grained pan salt, which presents a large surface for the attack of the acid, and open spaces for its absorption. This is, indeed, a general rule of some importance in manufacturing chemistry, that where agitation is not practicable fine compact-lying powders are less readily dissolved or otherwise acted on by liquids than such as are of a coarse grain. The purity of the Cheshire salt—not the rock-salt—is said to be a great advantage which British alkali makers

possess over their rivals on the Continent. Ferric oxide and alumina rank among the most troublesome impurities. Salt at the Lancashire works costs 6 to 8 shillings a ton; and though rock-salt—which is less suitable for alkali making—may be had at 3 shillings per ton, yet on the Rhine it costs 15 to 16 shillings, and in Saxony 17 to 28 shillings per ton.

As regards the sulphuric acid, its impurity of arsenious acid does not remain in the salt-cake, but is evolved with the hydrochloric acid. The best strength of the acid for decomposing salt is given as 140° to 144° T., which agrees well with our own observations in well-managed alkali works. Too great dilution is not always avoided if the works are provided neither with a concentrating-pan nor a Glover tower. Concerning the apparatus, close roasters are recommended where the muriatic acid is sold off the works, and where a high strength is consequently required to economise carriage. The arrangements for heating vary according to the relative prices of fuel and labour in different localities. Where the purity and colour of the sulphate are important lead pans are still used, as originally proposed by Leblanc; but where the salt-cake is for alkali making iron pans are preferred, for very obvious reasons. The various designs of decomposing-pans, and their arrangement in the furnaces, are described and figured at considerable length. The structure figured in Muspratt's "Chemistry" (iii., p. 908), and copied into several text-books, was never general in Lancashire and has been abandoned for some years. A good pan will last 2500 tons of sulphate, and sometimes even up to 4000 tons. Their construction is a secret known only to a few iron-founders, and requires a mixture of several brands of pig-iron. On the Continent the pans rarely last above 1500 tons of salt-cake, and will rarely bear a direct heat. Both the setting the pans and the way of working them have a great influence on their duration. It is very important that the sulphuric acid should not be run into the pan at temperatures below 80° to 100° C. If cold, cracking is almost unavoidable.

Heating blind-roasters with waste heat, as common on the Continent, is considered not economical, as the saving in fuel is outweighed by the increased labour and the multiplication of furnaces. But whether blind or open roasters are preferable is still a debated question, each system having its advantages and drawbacks. There is no proof whatever of a more complete condensation of the hydrochloric gas from blind-roasters. Dr. Lunge sums up to the effect that where it is needful to get as much strong acid as possible, whether for sale or for generating chlorine, blind-roasters ought to be employed. The gas-furnaces of Fletcher and of Gamble, intended to combine the advantages of open- and blind-roasters, are also described and figured.

The mechanical salt-cake furnaces, which are not dependent for their efficiency upon the skill, sobriety, and good-will of workmen have scarcely reached perfection. The arrangement patented by Cammack and Walker is pronounced extremely ingenious in its plan, but the mechanical difficulties in working have not been entirely overcome.

The yield upon the salt is calculated in England at 110 per cent. Absolutely pure and dry NaCl should give 121·45 per cent, and at New Stassfurt 120 has actually been obtained. The plan lately adopted in England of referring the yield of salt-cake, not to the sulphuric acid produced, but to the pyrites consumed, the author—very justly in our opinion—condemns as untrustworthy.

The Hargreaves process is described with great minuteness and accuracy, but its merits are left an open question. Among its drawbacks are mentioned a much higher first cost of plant, a probably larger cost of maintenance, a greater consumption of coal, and inequality in the character of the product.

We regret that we are not able to carry any further our survey of this excellent work. We are convinced that all competent judges who examine it will be fully satisfied with its accuracy and thoroughness, and regard it as a great boon to the trade.

A Manual of the Alkali Trade, including the Manufacture of Sulphuric Acid, Sulphate of Soda, and Bleaching-Powder. With 232 Illustrations and Working Drawings. By John Lomas. London: Crosby Lockwood and Co.

It might be supposed that of two books covering so nearly the same ground as the volume before us and Dr. Lunge's great treatise the one must necessarily render the other superfluous. This is, however, not the case. Though both works deal with the same subjects, and both are written by practical men, their point of view is in many respects different, and the one is no mere echo of the other. Mr. Lomas writes more as the manager, and seeks to produce a manual which alkali manufacturers may put into the hands of foremen "as a useful guide in their daily rounds of duty." He makes no attempt to give the general chemical characters of the materials used or produced. Theories of decomposition, analytical procedures, suggested improvements beyond such as have actually established themselves in practice, are rarely touched upon. But all arrangements which have on a fair trial proved themselves successful are described carefully and fully. Sound advice is given on many points which fall quite outside the usual scope of technical manuals. We may instance the selection of a site for intended works: the means of avoiding Sunday labour—a grave evil at many alkali works, as it always involves the demoralisation of the men, and renders them reckless, if not positively desirous of doing mischief. The question of time-work *versus* piece-work, and the adaptability of the latter to various departments of the alkali manufacture, is also discussed. Even such matters as the manufacture and cost of the casks used for packing the soda-ash are taken into consideration. It may surprise outsiders to learn that this apparently insignificant item represents close upon 10 per cent of the production-cost of a ton of alkali.

In passing the author refers to the uncertainty of the Liverpool alkali tests, as compared with those of Glasgow, Newcastle, and London. Hereby hangs a tale. We have heard that in the early days of the Lancashire alkali trade a chemist—whose name we forget, and who has long ago, as old Helmont put it, "been resolved *in terram damnatam*—made use of a most peculiar indicator in alkalimetry. When he judged that the operation was nearly complete he took up a drop of the liquid with the stirring-rod, put it in his mouth, and decided by taste whether the soda was exactly neutralised. It is, we think, to be regretted that the old and incorrect atomic weight of sodium, 24 (soda =32), is still maintained in the trade.

Mr. Lomas enters at some length into the noxious vapours' question. He quotes the "recommendations" of the Commission which sat from 1876 to 1878, and which would probably, but for the recent dissolution of Parliament, have ere this been embodied in a statute. With these recommendations we are only partially satisfied. They seem to aim at one fixed uniform standard for all parts of the country; enforcing the same degree of purity in a manufacturing district—where even in the absence of chemical works vegetation is destroyed by the fumes of sulphur dinoxide given off by burning coal rich in pyrites—as in agricultural districts, where no source of contamination exists. If, *e.g.*, a cotton-spinner burns in the furnaces of his steam-engines 20 tons daily of a coal containing 0 5 per cent of sulphur—no outside supposition—he will daily pour into the atmosphere the equivalent of 660 lbs. of oil of vitriol, equal to a million and a half of cubic feet of air containing 1 grain of sulphur per foot, with entire impunity, whilst his neighbour, the chemical manufacturer, may be subjected to pains and penalties, or even to the total suppression of his business, for a small fraction of such pollution. The recommendations, moreover, make no mention of a recently introduced nuisance which is carried on in the outskirts of London with intolerable

effrontery in localities completely surrounded by houses. We refer to ballast-burning, a process in which exceedingly offensive fumes are emitted, not from the tops of high chimneys, but so as to roll along the surface of the ground.

Another important feature of the work before us is the attention which the author pays to the construction of the various buildings and the strength of foundations for every part of the plant.

In case of simple facts, numerical results, &c., there is generally a fair agreement between Dr. Lunge and Mr. Lomas. Mr. Lomas is probably the less sanguine of the two. Though by no means an enemy to improvements, and though he points out various departments of the Leblanc process where there is scope for invention, he is apt to judge patents very rigorously. His opinion of the Glover tower is given as follows:—"It concentrates the chamber acid, increases the produce of the pyrites, and preserves the chamber itself. And yet it cannot be called by any means perfect. The plant is expensive and short-lived, and after all only saves some two-thirds of the nitre consumed. Probably its greatest virtues consist in the concentration of the chamber acid as aforesaid and in the preservation of the chambers."

The Deacon process for the production of chlorine Mr. Lomas pronounces "beautifully simple in reaction and productive of an enormous yield of cheap chlorine," and as "likely in some improved form to supersede all other chlorine processes."

On the Weldon magnesia process he remarks that "the whole of the chlorine is made available, and is actually utilised, so rendering possible an immense production of bleaching-powder. The apparatus required is of a simple description, and in no special way liable to get out of order. The amount of loss from leakages and other inevitable causes may be reduced to 2 or 3 per cent. But the process has never been practically successful, probably on account of the unremitting care required throughout. If the proper proportions between manganite and acid in the stills are not kept, so much magnesia has to be added to the liquors that the furnaced product contains an undue amount of this substance, and is worse than useless in the chlorine stills. Again, if the amount of protoxide in the manganite be too large a waste of acid in the still operation is incurred. The regulation of furnace temperature and of the admission of air are likewise delicate matters requiring constant attention.

Of the processes for the recovery of manganese from the still liquors Mr. Lomas pronounces Weldon's by far the best, its esseential feature being merely the addition of lime in large excess.

The Hargreave's process for the production of salt-cake he considers beautifully self-acting, but requiring very constant and intelligent watching. Many of the complaints made against this process are due to a careless preparation of the salt, especially the admission of fine dust into the cylinders.

To sum up, we may pronounce this a decidedly useful work, especially adapted for manufacturers, managers, and foremen. It should be kept for reference in all those establishments—becoming now, fortunately, more numerous—where "book-learning" is not scouted in favour of "rule of thumb."

CORRESPONDENCE.

CHEMICAL SOCIETY RESEARCH FUND.

To the Editor of the Chemical News.

Sir,—The following grants have been made from the research fund of the Chemical Society:—

£10 to Mr. Kingzett, for Experiments on the Atmospheric Oxidation of Phosphorus.

£25 to Watson Smith, for the Investigation of the Dinapthyls and Phenyl-napthalene.

£25 to Messrs. Bailey and Munro, for the Investigation of the Colour Reactions of Certain Metals and Metallic Solutions.—I am, &c.,

W. J. Russell.

Chemical Laboratory,
St. Bartholomew's Hospital, E.C.
July 5, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 23, June 7, 1880.

A Bromated Derivative of Nicotine.—A. Cahours and Etard.—The authors have not succeeded in reproducing C. Huber's compound, $C_{20}H_{13}N_2Br_5$. They have, however, obtained another bromine derivative of nicotine by dissolving 1 part of nicotine in 50 of water, and adding, with agitation, 4 atoms bromine per mol. of nicotine. An abundant yellow flocculent precipitate was formed. On heating the liquid to 65° to 70° by means of a current of steam, filtering and cooling the precipitate, long fine red crystals were deposited. If these crystals are dissolved in hydrobromic acid, the solution, on cooling, deposits a crystalline product less red than the former, probably a hydrobromate of the primitive derivative. This compound has the composition $C_{20}H_{14}N_2Br_4$. Huber's compound is probably a hydrobromate of this derivative formed by addition.

Direct Measure of the Interior Resistance of Magneto-electro-machines in Motion.—G. Cabanellas.—The intensity of the current circulating in the ring being i webers per second, and the difference of the potential between the two extremities of the connected rings being represented by ε volts, the resistance of the ring is given by $\frac{\varepsilon}{2i}$.

Transformation of War Powder in the Metal Cartridge Boxes of the Infantry.—E. Pothier.—It appears that gunpowder preserved in contact with certain metals, especially zinc and copper, undergoes a gradual change. Potassium sulphide, sulphate, and carbonate, and ammonium sesquicarbonate are produced along with sulphides and basic salts of the metals derived from the decomposition of the brass of the boxes. The strength of the powder was found considerably reduced.

Colloidal Oxide of Iron.—L. Magnier de la Source.—The author concludes that ferric hydrate is in certain conditions soluble as such without there being any need to assume that it enters into combinations of greater or less complexity.

A New Aluminium Sulphate (Sesquibasic).—P. Marguerite.—On examining aluminium sulphate resulting from the decomposition of ammonia alum by heat a new sulphate has been obtained, answering to the formula $Al_2O_3,2SO_3,12HO$. If this formula is calculated for 3 equivs. sulphuric acid it would be $\frac{2}{3}Al_2O_3.3SO_3,18HO$, and if compared with the monobasic, bibasic, and tribasic sulphates it would be sesquibasic salt. It occurs in well-defined crystals, rhombohedra, sometimes simple and sometimes terminating in four-sided pyramids. It dissolves readily in hot and cold water. It is almost neutral to litmus paper, and is without action upon ultramarine. It contains 21 per cent of alumina, that is twice as much as alum and one half more than the ordinary sulphate. The new compound is the tenth simple aluminium sulphate which has been obtained and analysed.

Action of Chlorine upon Chromium Sesquioxide.—H. Moissan.—The author has examined the behaviour of chromium sesquioxide in a current of chlorine gas, dry or moist. If the oxide has been previously ignited there is no action. If the hydrated sesquioxide is employed, and heated progressively to 440°, vapours of chloro-chromic acid are evolved. The sesquioxide in a current of oxygen behaves with a corresponding difference in the reaction. Chromium sesquioxide is the type of the oxides in which a change of properties coincides with a disengagement of heat.

A Compound of Allylic Alcohol with Anhydrous Baryta.—MM. C. Vincent and Delachanal.—The authors show that allylic alcohol forms with baryta a compound analogous to those formed by the other alcohols, and exceedingly instable.

Fixity of the Composition of Plants: Relation between Starch, Phosphoric Acid, and Mineral Substances in the Potato.—H. Pellet.—The author concludes that there is a constant ratio between the total phosphoric acid contained in the entire plant and the starch. There is also a constant ratio between the starch and the total mineral matter absorbed, less silica. There are great differences in the proportions of lime and potash with relation to 100 parts of starch. There is an equivalent substitution of these alkalies, so that the quantity of sulphuric acid required to saturate all the bases is approximately the same. Silica and nitrogen range between wide limits.

Analysis of Beet-root Seed.—H. Pellet and M. Liebschutz.—The results of the analyses are given in a lengthy table.

Disinfection and Preservation for Agricultural Purposes, and especially of Blood, by means of Aluminium Bisulphate and Nitric Acid.—E. Vautelet.—The author adds to the blood, &c., sulphate of alumina, sulphuric acid, and nitric acid. He considers that on adding sulphuric acid to sulphate of alumina there is formed a bisulphate less soluble than the sulphate, which quickly determines a perfect coagulation of the blood.

No. 24, June 14, 1880.

On Papaine: A Contribution to the History of Soluble Ferments.—A. Wurtz.—An account of the composition and behaviour of papaine, the active principle of the juice of *Carica papaya*. As regards its action upon albuminoid matter papaine approaches the pancreatic ferment which has been studied and named trypsine by M. Kühne. Papaine dissolves fibrine in presence of prussic and boric acids and of phenol, *i.e.*, under conditions which exclude the formation and agency of microbia. The author has also extracted from Carica juice a saponifiable fatty matter and a crystalline nitrogenous principle.

M. Stas has been elected, by a large majority, corresponding member of the Academy for the Chemical Section in place of the late M. Zinin.

Experimental Researches on Rotatory Magnetic Polarisation in Gases.—H. Becquerel.—The author has studied five gases—oxygen, nitrogen, carbonic acid, nitrous oxide, and olefiant gas. In all these, except oxygen, the author finds that the magnetic rotations of the planes of polarisation of rays of different wave-lengths are almost inversely as the square of the wave-length, as is the case with non-magnetic bodies, solid and liquid. Oxygen gives for the red rays a rotation very little superior to that of the green rays. It might be supposed to be a mixture of two bodies, the one magnetic and the other diamagnetic.

Constancy of the Proportion of Carbonic Acid in the Air.—T. Schlœsing.—The author considers that the sea exercises a regulating action upon the proportion of carbonic acid present in the atmosphere as well as upon that of watery vapour and ammonia. It is admitted that the sea if extended in a vertical layer over the whole surface of the globe would have a depth of 1000 metres. The quantity of carbonic acid contained in a vertical prism of this stratum, having a base of 1 square metre, is 98·3 kilos. These 98·3 kilos. forming bicarbonates, half the quantity, 49 kilos., is retained by the bases. Supposing that the atmosphere has a uniform composition, and contains in volume 2-10,000ths of carbonic acid, a vertical prism of this atmosphere with a base of 1 square metre would contain only 4·7 kilos. of carbonic acid. The sea thus holds in reserve a quantity of carbonic acid available for exchange with the air ten times greater than the total quantity contained in the latter, and, *a fortiori*, very much greater than the variations of such quantity.

The Tensions of Saturated Vapours have Different Modes of Variation, according as they are emitted above or below the Melting-point.—Paul de Mondesir.—This paper is not adapted for useful abridgment.

Action of Methyl Iodide and Bromide upon Monomethylamine.—E. Duvillier and A. Buisine.—The action of methyl bromide yields tetra-methyl-ammonium bromide. That of the iodide is similar. As the most advantageous source of dimethylamine, the authors recommend the trimethylamine of commerce.

Transformation of Terebenthen into Cymen.—M. Bruère.—Terebenthen and ethyl sulphate form an unstable compound, which, if decomposed by heat, yields cymen and ether.

Preparation of Indoline and of its Compounds.—E. Giraud.—Flavindine is dissolved in a very dilute solution of caustic soda and is placed in contact for two or three days with sodium amalgam. A dirty yellow powder is deposited, which is freed from excess of soda by washing in water, dissolved in alcohol, re-precipitated with excess of water, and washed.

Justus Liebig's Annalen der Chemie,
Band 201, Heft 2 and 3.

Communications from the Laboratory of the University of Würzburg.—These communications comprise a paper by G. H. U. Harrow on the products of the decomposition of diacet-succinic ester by sulphuric acid, *i.e.*, carbo-pyro-tritaric acid and pyro-tritaric acid, and a memoir by W. R. Hodgkinson on the action of sodium upon isobutyric benzyl-ester.

Certain Ultramarine Compounds (Second Memoir).—Karl Heumann.—The author here describes the behaviour of silver ultramarine with dilute acids, with solution of sodium chloride, with soda lye, with fused haloid alkali metals, and the conversion of silver ultramarine into the potash compound. Then succeeds an account of potassium and lithium ultramarine, of blue sodium ultramarine and ammoniacal solutions of silver, green ultramarine and its behaviour with the silver salts.

The Constitution of Cinchonin and Cinchonidin.—Zd. H. Skraup.—Not suitable for abstraction.

Alizarin Blue.—C. Graebe.—The author ascribes to this compound the formula $C_{17}H_{11}NO_4$. Its formation from nitro-alizarin and glycerin depends on the simultaneous elimination of water and oxygen. The latter does not appear in the free state, and is doubtless concerned in the formation of the abundant brown secondary products. Alizarin blue is easily attacked by oxidising agents, such as nitric acid and permanganates, the chief product being phthalic acid. With reducing agents in an alkaline solution it yields a reduction-vat, analogous to the indigo-vat, from which the colouring-matter is re-precipitated with a blue colour on exposure to air. The author considers alizarin blue as an anthracen derivative, in which the hydrogen atoms of one benzol nucleus are not replaced by other elements.

Colour Bases from Furfurol.—Hugo Schiff.—The author describes the compounds which furfurol forms directly with the aromatic amine acids, such as the amido-benzoic and amido-cuminic.

Guanidin, an Oxidation Product of Albumen.—F. Lossen.—The substance obtained nearly thirty years ago by Béchamp, by the oxidation of albumen with potassium permanganate, and supposed by him to be urea, is guanidin.

Reply to the Communication of H. Kessler "On the Supposed Non-existence of Pentathionic Acid."—W. Spring.—The author contends that the phenomena adduced by Kessler in support of the existence of pentathionic acid tell in the opposite direction.

Reimann's Färber Zeitung,
Nos. 17 and 18, 1880.

These numbers contain nothing of general interest.

No. 19, 1880.

It is announced that Dr. Nölting succeeds Dr. Goppelsroeder as Professor at the Ecole de Chimie of Mulhouse.

The question is raised whether a course of two years in this institution is a sufficient training for colourists. It is suggested as an improvement that pupils before entering must produce evidence of a satisfactory proficiency in general and analytical chemistry, so that the two years may be entirely devoted to the chemistry of colour.

No. 20, 1880.

This number contains nothing of general interest.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 17, Apil 22, 1880.

Considerations on the Experimental Possibility of the Dissociation of Certain Non-metailic Bodies.—Raoul Pictet.—The author proposes to submit the elementary bodies to be decomposed to the heat of the sun, concentrated by a parabolic reflector of 10 metres in diameter. The "solar chamber" for the reception of the bodies is to be made of lime or zircon.

Just published super-royal 8vo., with 232 Illustrations and Working Drawings, and 380 pp. of Text, price £2 12s. 6d., cloth,

A MANUAL OF THE ALKALI TRADE,

Including the Manufacture of Sulphuric Acid, Sulphate of Soda, and Bleaching-Powder. By John Lomas, Alkali Manfacturer, Newcastle-upon-Tyne and London.

"This book is written by a manufacturer for manufacturers. . . The working details of the most approved forms of apparatus are given, and these are accompanied by no less than 232 wood engravings, all of which may be used for the purposes of construction. . . Every step in the manufacture is very fully described in this Manual, and each improvement explained. Such misconceptions as still linger and retard the satisfactory application of scientific discoveries to the alkali trade are closely examined, and everything which tends to introduce economy into the technical details of this trade receives the fullest attention."—*Athenæum.*

"The author is a practical man. We find here not merely a sound and luminous explanation of the chemical principles of the trade, but a notice of numerous matters which have a most important bearing on the successful conduct of an Alkali Works, but which are generally overlooked by even the most experienced technological authors. All needless details of an historical or of a purely theoretical character have been judiciously omitted."—*Chemical Review.*

CROSBY LOCKWOOD and Co., 7, Stationers' Hall Court, London, E.C.

KING EDWARD'S SCHOOL,
BIRMINGHAM.

The post of SCIENCE MASTER in the High School is vacant. Salary £250, with an annual increase up to £400.

Applications, accompanied by not more than three testimonials, should be sent in, not later than the 17th July, 1880, to the Secretary, King Edward's School, Birmingham, from whom further particulars may be obtained.

King Edward's School, 22nd June, 1880.

ROYAL POLYTECHNIC.—Shakesperian Recitals: Scenes from "Hamlet" at 7.15 p.m. daily; and at 3.30 on Monday, Wednesday, and Saturday. Hamlet, Mr. Marlande Clarke; Ophelia, Miss H. Shea; The Queen of Denmark, Miss Eva Russell; Polonius, Mr. Heath; 1st Grave-Digger, Mr. Weatherhead. Lectures on the Phenomena of Nature, the Microscope, London, Phosphorescence, &c., &c. Ghost Entertainment, Bloncin, the Wonderful Automaton. Admission, 1s.; Reserved Stalls 3s.; may be booked at all the Libraries.

THE JOURNAL OF SCIENCE
for July (Price 1s. 6d.), includes—

The Evolution of Scientific Knowledge. By C. Lloyd Morgan.
Habits and Anatomy of the Honey-bearing Ant.. By C. Morris.
The "Laws of Emphasis and Symmetry." By J. W. Slater.
Instinct and Mind. By S. Billing.
Tuberculosis transmissible through the Meat and Milk o Animals affected with it.
Natural Science and Morality. By S. Tolver Preston.
Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44. Berners-street W.

Established 1798.

ROBERT DAGLISH & CO.,
ENGINEERS, BOILER AND BRIDGE MAKERS, MILLWRIGHTS,
BRASS AND IRON FOUNDERS.

Manufacturers of every description of Condensing, or High-pressure Blowing, Pumping, Rolling, Winding, and Patent Steam-engines, of any required power, for Irrigating, Draining, Mining, Rolling Mills, or Water Works purposes, and Manufacturers of every description of hemical, Colliery, Copper Ore, Gold Mining, Glass, and Rock-salt Machinery.

Black-ash Revolving Furnaces of the Most Approved Type.

Bessemer Steel-Rail Plant.

Compressing-Engines for Collieries, Iron Works, and Weldon's Patent Bleaching-Powder Process.

Caustic, Chlorate, Decomposing, Nitre, Nitro-Glycerine, Iodine Potash, Sulphur, Acid, and Oxalic Pans.

Gas Producers Patent for Heating and other Purposes.

Pyrites Burners for Irish, Norwegian, and Spanish Ores of Improved Construction.

Patent Rousing Machinery for Brewers.

Retorts, Acid, Gas, Iodine, Nitric, Nitre, Nitro-Glycerine and Vitriol Refining.

Steam Superheaters improved for Oil, Tar, and Resin Refining.

Steam Sulphur Melter.

Stills for Oil, Resin, and Tar.

Wheels, Bevel, Mitre, and Spur Moulded on the Shortest Notice by Patent Machinery.

Makers of Mactear's Patent Carbonating Furnace, Jones and Walsh's Patent Sulphate of Soda Furnace, Parnell and Simpson's Patent Causticiser, and Kynaston's Patent Alum Plant.

Lists sent on Application.

Photographs, Plans, and other information supplied on receipt of Order.

ST HELEN'S ENGINE, BOILER, AND BRIDGE WORKS AND FOUNDRY,
LANCASHIRE.

BISULPHIDE OF CARBON,
CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,
161 162 163, Palmerston Buildings, London, E.C

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

JESSE FISHER & SON,
Phœnix Chemical Works Ironbridge.

GREENBANK ALKALI WORKS COMPANY
(LIMITED),
ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums, or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{2}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{1}{200}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

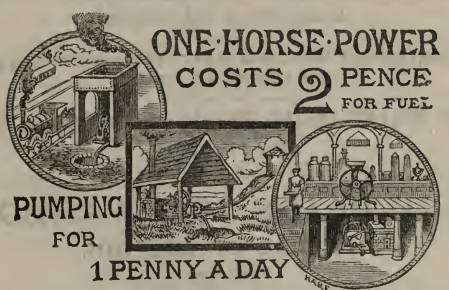
PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

BAILEY'S PATENT HOT-AIR ENGINE.



Made from ¼ to 5 horse-power. 56lbs. of coke will keep a 1-horse going 12 hours. 1000 galls. of water lifted 50 feet high for a penny.

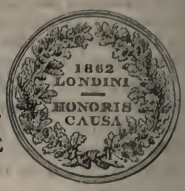
NO BOILER. NO DANGER.

Awarded Prize Medal by the chief Societies.

W. H. BAILEY & Co., Albion Works, Salford, Manchester.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

BISULPHIDE OF CARBON



PROTOSULPHATE
RED OXIDE
OXYCHLORIDE
Sulphocyanide,
And every other Mercurial Preparation.

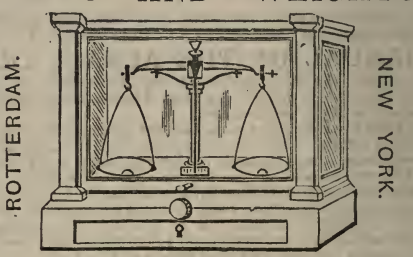
BISULPHITE OF LIME, TETRACHLORIDE OF CARBON.
Oxysulphuret of Antimony, Glacial Acetic Acid,

LIQUOR AMMONIÆ,	PERCHLORIDE OF IRON,
SULPHIDE OF IRON,	SULPHITE AND HYPOSULPHITE OF SODA,
PURE ACIDS,	PHOSPHATES OF SODA AND AMMONIA,
CHLORIDE OF SULPHUR,	ETHERS,
ACETONE,	BROMIDES,
CHLOROFORM,	IODIDES,
ALDEHYDE,	SCALE AND GRANULAR PREPARATIONS,
CHLORATE BARYTA,	SULPHIDE OF SODIUM.
ARSENIC ACIDS,	
FRUIT ESSENCES FOR CONFECTIONERY & LIQUEURS,	

ALSO,
Pure Photographic Chemicals of every kind.
MANUFACTURED BY
WILLIAM BAILEY & SON,
HORSELEY FIELDS CHEMICAL WORKS,
WOLVERHAMPTON.

BECKER & SONS,

MANUFACTURERS OF
CHEMICAL AND GOLD ASSAY. BALANCES
AND OTHER
SCALES AND WEIGHTS.



BECKER'S STUDENT'S BALANCE, in polished mahogany glass case, sliding front, counterpoised, to carry 30 grammes in each pan and turn to ½ milligramme, nickel plated pans £2 10
Ditto, ditto, in mahogany glass case, polished black.. .. .. £2 13

Sole Agents for England, Ireland, and Wales:—
TOWNSON & MERCER.

Becker's Complete Lists forwarded by post on receipt of 1*d.* stamp or free on application.

WILLIAM AND WILLIAM T. FIELD
MANUFACTURERS of the Celebrated STAFFORDSHIRE BLUE BRICKS, specially adapted for Chemical Plant, *i.e.*, Acid Towers, &c. Also all other kinds of Best Staffordshire Blue Bricks, Pavings, Plynths, Splays, Copings, &c. &c. Prices and samples on Application.

TESTIMONIAL.

"We have used the Blue Staffordshire Brick or Sulphuric Acid Towers, &c., manufactured by Messrs. Field, for the last fifteen years during which time they have given great satisfaction. We recommend them to the Chemical Trade, believing there is nothing better in the market."—(Signed) WILLIAM HUNT and SONS, Lea Brook Alkali Works, near Wednesbury, Staffordshire, February, 1878.

TOLL END BRICK-WORKS,
TIPTON, STAFFORDSHIRE.

THE CHEMICAL NEWS.

Vol. XLII. No. 1077.

DETECTION OF COTTON-SEED OIL IN ADMIXTURE WITH OLIVE.

By BENJAMIN NICKELS, F.C.S., F.I.C.

A continental firm (consumers of oils) consulted with me on a recent occasion as to the simplest method of detecting admixtures of "cotton-seed oil" with "Lucca or Gallipoli," making a strong point of the want of such a test amongst consumers. Without entering upon the admitted difficulty of the case as regards the chemical aspect of the question, it has occurred to the writer that something might be done in the direction indicated by spectroscopic examination.

Pure "olive or Gallipoli," as examined by a Browning "direct vision" or pocket instrument, presents a deep shadowing or cutting-out of the blue and violet ray, with a fine, almost indistinct, line in the green, and a strong deep band in the red.

Refined cotton-seed oil similarly examined presents exactly the same appearance, but as regards the blue and violet ray only, the green and red being continuous.

Now if we take as a standard a given stratum of pure olive or Gallipoli, say in a test-tube ⅜ or ½ in. in diameter, and a similar stratnm or thickness of the standard oil in admixture with cotton-seed, there is no discernible difference as regards the shadowing in the blue and violet ray, but an almost entire fading out of the delicate line in the green, and a considerable diminution in the depth and intensity of the strong band in the red, consequent upon "dilution" or "thinning down." With 50 per cent in admixture the loss in intensity is considerable; with 25 per cent the variation is marked and discernible.

A suspected sample compared with, and differing thus from, the standard, and in the absence of any direct chemical evidence as to the nature of the oil in admixture, might fairly fall within the range of strong presumptive evidence pointing towards "cotton-seed" oil as the probable dilutant.

Laboratory, 104, Leadenhall Street, E.C.

A NEW LECTURE EXPERIMENT— THE CUPELLING OF GOLD AND SILVER

Mr. Holman, the Actuary of the Institute, has constructed a lantern for the oxyhydrogen light, which combines a great many advantageous qualities. It may, at a moment's notice, be changed into a vertical lantern for showing precipitations, the action of a magnet on iron filings, &c., on the screen. It may be converted into a projecting microscope in a moment, and with equal facility it becomes a megascope for projecting the image of solid objects. A course of lectures by Mr. A. E. Outerbridge, Jr., of the U.S. Mint, was recently delivered before the members of the Institute on "Coins and Coinage." By the aid of Mr. Holman's apparatus the enlarged images of rare and valuable ancient and modern coins were projected upon the screen with great sharpness and brilliancy, having the lustre and effect of relief of the coins themselves, and the lecturer was enabled to show the cupellation of gold and silver, as performed in the assaying of the precious metals at the Mint, in a very beautiful manner to the entire audience, thus opening up a new field of usefulness for the projecting lantern in illustrating lectures on metallurgy.

A little "cupel" or crucible, made of calcined bone-ash, was held in the focus of the light from the condensing lenses of the lantern, by means of a ring of thick copper wire. The image of the cupel appeared upon the screen greatly enlarged. The cupel was then heated to a white incandescence by means of an oxyhydrogen blowpipe. A weighed sample of gold alloy containing base metal was enclosed in an envelope of sheet-lead, pressed into the form of a bullet; this was dropped into the cupel and was immediately melted. As the lead became oxidised it was gradually absorbed in the cupel, forming a dark ring in the bottom. A little sheet of light was noticed moving over the surface of the molten metal as the non-oxidisable precious metal became exposed to view; then, at the moment that the lead became completely absorbed, carrying with it all the base metal originally contained in the alloy, the purified precious metal became visible as a brilliant globule, reflecting the light falling upon its surface like a mirror.—*Journal of the Franklin Institute.*

STRONG'S WATER-GAS SYSTEM.

By GEORGE S. DWIGHT.

Some two years since, the representatives of the Strong process publicly announced that it was possible to convert the best anthracite coal to a gas, which should possess a greater heating value than the fuel from which it was derived, for practical purposes. The objection was at once raised that here was an absurd attempt to extract from a given weight of carbon more calories than it contains. The charge was based upon the undeniable truth that the burning of C to CO implies the expenditure of a proportion of its heat, and hence the new form must represent less calorific energy than the old.

Prompt answer was made, admitting this last fact, but explaining that the objection was theoretic and not practical; that the comparison must not lie between the potential energy of a fuel and that of its gaseous product (except for certain limited purposes), but between their several *actual* energies. It was shown that the theoretic heating-powers of fuels are determined by delicate laboratory methods, which, however precise and valuable, are utterly unattainable by ordinary practice; that the steel-makers of Sheffield utilise only 3 per cent of the value so ascertained, consumers in the domestic industries not over 10 per cent; while the most economical use of fuel ever attained, namely, in the largest and most perfect blast-furnaces, does not exceed 36 per cent. The better result claimed for some boilers was excluded from the comparison on the apparently just ground that, as the generation of steam is specifically for the driving of engines, the utilisation of heat should be judged by the power developed rather than the weight of water evaporated, and that, so judged, the loss is as great as in other fuel applications.

Evidence was then offered that in the combustion of the Strong gas it is possible to utilise within 10 to 12 per cent of its full theoretic value, and it remained only to make a comparison of results, which was done substantially in the following manner:—

One pound of anthracite possesses a potential energy of 13,500 units of heat, of which the *actual* energy, namely, that realised in practical operation, is, as we have already seen, from 3 to 36 per cent thereof, or 405 to 4960 units of heat, according to the manner of its use. The gaseous products of 1 lb. of anthracite, by the Strong system at that time, was 22·33 cub. ft. × weight 0·04116 = 0·919 lbs., possessing a potential energy of 0·919 × 8,798 = 8012 units of heat, and an actual energy of from 8⅓ to 90 per cent thereof, or 7121 to 7290 units,

Assuming for simplicity what is, perhaps, not an unfair assumption, that the labour-cost of conversion is compensated by collateral advantages in the reduced labour of using gas-fuels, the consumer was left to decide the simple question, from which form of fuel he would realise the greater number of heat-units,

This answer on the parts of the advocates of the new system seemed intelligent and correct; at all events, it has never been controverted. Admitting it to be so, we must acknowledge also that the new method of converting carbon into superheated steam, instead of atmospheric air, represents an important advance in the art of combustion.

More recently, additional facts of great interest have been developed by further experience with the Strong furnace more perfectly constructed. The opinion that a great variety of fuels could be utilised by it has been justified by the results, and the gratifying fact established that all yield nearly identical gases, the variation being not in quality but in volume, which is consistently in proportion to the amount of carbon contained in the fuel. The special excellency of this system in rendering available certain cheap and abundant forms of fuel, heretofore deemed inferior and so neglected, such as small coals, culm and peat-dust, and which were employed in the proportion of 3 lbs to 1 lb. of the better grade, is now ascertained to have a more important significance than the utilisation of cheap material, important as that is.

The facts now to be stated will certainly revive the original objection that the method is claiming to get more out of the fuel than it contains. Let the proposition be stated in the clearest possible manner. In the earlier operations the advantage was claimed to be a practical one, shown as already explained, by a comparison between the energies actually derived, it being admitted that the potential energies of the fuel and the gas were related as 8092 is to 13,500; that is, that the loss by conversion was 5408 units of heat, equivalent to about 40 per cent of the theoretical calorific value of the fuel.

Now, it is claimed that this percentage of loss has, by greater skill and experience in applying the principle, been steadily reduced, till, in some instances, it almost disappears. In other words, the potential energies of the crude fuels and their gaseous products, as heretofore determined by scientists, are approaching so closely as to indicate that the Strong system will yet develop what is now understood to be the maximum theoretical energy of the fuel in its gas. Here are the facts:—

1. If 1 lb., say, of English coke is blown to a red heat upon the grate of the Strong furnace, and the heat of the resulting products of combustion are stored in its regenerating chambers, and used to make and superheat a proper quantum of steam, and this latter is led directly back to the coke, it is ascertained that the largest yield of gas thus far attainable is 25·79 cubic feet.

The potential energy of this gas is as follows:—

25·79 cubic feet × 0·04116 = 1·06 lbs. × 8798 = 9326 units.
The potential energy of the 1 lb. coke is 13550 units.

This, it will be observed, is an improvement upon the earlier results of 1234 units of heat per pound of fuel, and the loss by conversion is so reduced to 31 per cent of the potential energy.

2. If 1 lb. of English coke is treated as before, but the superheated steam is intercepted before coming in contact with the incandescent coke by a shower of pulverised fuel, it is possible to convert a larger weight in that form, and the yield in gas, proportionally to the purity of the dust-fuel (that is, its percentage of carbon), will be greatly increased. Take peat-powder of the following composition:—

Water	17·90
Combustible gas	20·12
Non-combustible gas	20 05
Carbon	26 87
Ash	15·00
	99·94

When 3 lbs. of this material are used, the total gas produced is 101·96 cubic feet. Deducting from this volume the 25·79 cubic feet, which, as already shown, are obtainable from the coke, leaves 76·17 cubic feet as derived from the peat, or 25·39 cubic feet of gas for each pound of peat used.

The total gas product possesses the following potential energy:—101·96 × 0·04116 = 4·196 × 8798 = 36,916 units. The potential energy of the fuels from which it was derived is:—

3 lbs. peat × 7854 = 23,562
1 ,, coke = 13,550—37,112

Showing a loss of potential energy of 196 units of heat only. This is equivalent to a loss of but 49 units of heats for each pound of fuel, as against 4224 where the coke was used alone without dust-carbon.

If the calorific value of the peat is compared directly and separately with that of its own gas, we meet a surprising result, namely:—

76·17 cubic feet × 0·04116 = 3·135 × 8798 = 27,581 units.
3 lbs. peat × 7854 = = 23,562 ,,

Here the gas stands related to the fuel as 1·17 to 1, equivalent to a gain of 4019 units of heat, or 17 per cent even upon the basis of potential energies! What becomes of the law of loss in conversion? It is not disturbed, but most strikingly illustrated. The seemingly impossible result is not beyond an explanation, and one which appears to vindicate a theory advanced by the advocates of the new system, and yet to be generally admitted, namely, that in the conversion of carbon from the solid to the gaseous state there is a proportion of the energy of the fuel expended in its own gasification, which is productive of no other effect, and which has never entered into the laboratory tables concerning calorific values. In other words, that the ultimate maximum potential energy of carbon is greater than the accepted estimate.

Take, as example, the conversion of the peat just explained, the heat essential to the act was furnished entirely by the coke, exerted through the medium of the steam, and hence the carbon of the peat went directly and without reduction into union with the oxygen of the water to form gas, representing 9193 units of heat per pound. When the analyst sought to determine the calorific energy of the peat, he obtained 7854 units only. The difference of 1339 units, or a considerable proportion thereof, we must infer was expended in the gasification of the crude fuel, which, according to this theory, is not merely a part of combustion, but a pre-requisite to it. This theory is based upon the proposition that only the gases contained in fuel materials are combustible; and that whatever heat was, during the processes of nature, expended in their solidification from their original gaseous form, must be repaid to restore it and render them available in combustion.

Let us for the moment regard heat-units as a merchantable article, like any other commodity of purchase and sale, and, comparing the above figures upon this commercial basis, see in what market or in what shape we can most advantageously buy.

Assume that lump anthracite coal or coke is selling at four dollars per ton of 2240 lbs., and coal-dust or peat at one dollar for the same weight, and that we have one dollar to spend for practical heat-units, that is, for such as we actually get the value of in combustion:—(See Table on next page).

Bear in mind that the figures are *not* theoretic (except in case 4), but show the calorific values *actually obtained in practical combustion*. The prices, of course, represent the material cost of manufacturing at wholesale only, but they indicate that the gas-maker has a margin for liberal profit without being unreasonable. Naturally the gas purchaser will always determine for himself, as in any other transaction, whether the price charged is in excess of the advantages gained, into which calculation many collaterals, as to the convenience, comfort, and reduced labour attending the use of gas fuels, must enter. And he will always have the alternative of a return to crude fuels, if the gas manufacturer becomes exorbitant in his demands.

	Units of Heat.	Cost per Unit in Mills.	P.c. of Potential Energy of Fuel Utilised.
1. If we pay one dollar for lump coal, applied as in Sheffield steel-making, we obtain	226,800	0·00440	3
2. The same sum, as applied in domestic uses, gives	756,000	0·00132	10
3. The same in the most perfect blast-furnace ..	2,716,100	0·00036	36
4. One dollar's worth of lump coal, converted by the Siemens generator, will yield gas representing theoretically* ..	2,451,874	0·00040	30
5. One dollar, for lump coal or coke, converted to water-gas, as explained, and burned with 10 p.c.	4,706,894	0·00021	62
6. The same sum, expended for ½ the lump coal or coke and ½ peat, and converted by Strong's system, as explained, yields, after allowing 10 per cent loss	10,623,630	0·00009	89

The table represents both clearly and accurately the advantage possessed by the Strong principle, not only as compared with general methods of employing crude fuels directly, but also shows at a glance how far it stands in advance of all preceding gas methods, including even those that rely upon the conversion of carbon in an atmosphere of steam. This last remark may be emphasised in passing by the statement that careful investigation indicates that, where lump fuel is exclusively used in the decomposition of the steam, as described earlier in this paper, little or no further increase of heat-units—that is, no greater volume of gas—will be probable. A slight gain may result from a reduction of loss by radiation and a further utilisation of the sensible heat of the products of the gas furnace; but beyond these trivial gains, the process cannot apparently advance.

Not so, however, when the principle is applied to the conversion of carbon dust. The principle itself is so perfect as to admit of no improvement, and yet an increasing experience in its management may still further develop its efficiency. It is manifest, from what has been stated, that the conversion of a small additional proportion or weight of dust beyond that already successfully used will enable this system to deliver gas representing the full potential value of the fuels as at present estimated. This is a daring promise to make; but we may be trustful of a method which has hitherto kept its pledges so well, and predict a not distant fulfilment of this latest one. The application of the steam principle has had an almost immeasurable influence upon the industries of civilisation. The Strong system of conversion is certainly no less important than that, and may, indeed, be said to be the development of that principle to a yet grander plan of beneficent usefulness.—*The Engineering and Mining Journal*, May 29, 1880.

Stockholm, February 23, 1880.

Chemical Society.—Dr. J. H Gladstone, F.R.S., has presented £100 to the Research Fund of the Chemical Society.

* In this last computation, the coal is credited with three times the volume of gas, namely 150,000 cubic feet per ton, stated by Percy in *Metallurgy* (p. 528). But as recent investigations prove this gas can only be burned with great loss, if used without the regenerative system, and to be entirely inefficient for general distribution, only its theoretic value is given in this table.

CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF MICHIGAN.*

By ALBERT B. PRESCOTT.

I. Aluminates of Potassium and Sodium in Solution.

The composition of certain solid aluminates of metals of the alkalies and alkaline earths was well established long ago. Also, there are recorded observations of the action of water upon alkali aluminates, either effecting complete solution, or partial dissociation. Not finding statements of the proportions of potassium hydrate and sodium hydrate necessary to dissolve precipitated aluminium hydrate, the writer instituted determinations of these data, in order to show the atomic ratio of K and Na, to Al, in the aluminate solutions with different quantities of water, in the conditions of re-dissolved precipitate so common in chemical operations.†

Potassium Aluminate.

Two solutions of aluminium salt were used, one a decinormal solution of potassium aluminium sulphate, $K_2Al_2(SO_4)_4.24aq.$; the other, one-third stronger, or tenth of 1⅓ normal solution of the same salt—this being a nearly saturated solution. These aluminium salts solutions were treated respectively with normal and decinormal solutions of potassium hydrate, KOH, until the precipitate at first formed had just all dissolved. The determinations were made at 30° C., then at 50°, and then at 70°; and each determination was made by triplicate trial. The three trials, accepted for each determination, did not vary one from another by as much as two-tenths cubic centimetre. The trials at the different temperatures gave the same results. When the results were attained, that the aluminium precipitate had just dissolved under the continued addition of the potassium hydrate, it was found that the addition of the first drop of decinormal solution of sulphuric acid, in all trials, reproduced the precipitate. In most cases, the quantity of aluminium salt solution taken was 5 c.c. It was the single result, under all the conditions of dilution and temperature named, that *1 c.c. of a decinormal aluminium salt solution required 8 c.c. of decinormal potassium hydrate solution.* (Thus, 5 c.c. of decinormal Al_2 solution took 40 c.c. decinormal K solution, and took 5 c.c. normal K solution; and 5 c.c. tenth of 1⅓ normal Al_2 solution required 53·5 c.c of decinormal K solution, and again 5·4 c.c. of normal K solution). This gives the proportion of potassium to aluminium, in the soluble aluminate—

$$K_2Al_2O_4, \text{ or } Al_2\begin{cases} O \\ O \\ (OK)_2 \end{cases}$$ And the equation is:

$$K_2Al_2(SO_4)_4 + 8KOH = K_2Al_2O_4 + 4K_2SO_4 + 4H_2O.$$

Calculation gives the following as the number of parts of water (*i.e.*, water solution of potassium sulphate) present for one part of the soluble potassium aluminate, in the several degrees of dilution:

	Solution.
With Al_2 tenth of 1⅓ normal, and K normal	79 parts.
,, decinormal, ,, ,,	91 ,,
,, tenth of 1⅓ normal, ,, decinor.	445 ,,
,, decinormal, ,, ,,	456 ,,

Over fifty years ago the compound $K_2OAl_2O_3(K_2Al_2O_4)$ was obtained by saturating potassium hydrate solution with aluminium hydrate, evaporating to a small bulk, and removing all excess of alkali by alcohol.‡ Fremy obtained crystals of $K_2Al_2O_4.2aq.$, after fusing the alumina-saturated potash residue.§ It was stated by Fremy that the di-

* From the *Journal of the American Chemical Society*, vol. ii.

† These operations for determination of potassium aluminate and sodium aluminate, were entrusted to the execution of Mr. J. N. Ayres.

‡ *Pogg. Annaln*, 7, 723; "Gmelin's Handbook," 3, 320.

§ *Ann. Chem. Phys.* (3), 12, 362 (1846); *Comptes Rendus*, 15, 1106.

potassium aluminate, $K_2Al_2O_4$, is decomposed by much water, precipitating aluminium hydrate, and leaving in solution an aluminate probably $K_6Al_2O_6$. The symmetry of the compound last named, $Al_2(OK)_6$, may have had some influence in its frequent adoption, to represent the potassium hydrate solution of alumina. In nature, the form $R''Al_2O_4$ is represented by the spinels; and dibasic aluminates are formed by precipitating alkali aluminate solutions with barium or calcium hydrate solution, as is well known.

Sodium Aluminate.

Trials were made with decinormal and normal solutions of sodium hydrate, corresponding in all particulars to the trials above described for potassium aluminate. The results were not different in any particular. 1 c.c. of the decinormal aluminium solution, or its equivalent, gave a precipitate exactly dissolving on addittion of 8 c.c. of decinormal sodium hydrate solution, or its equivalent. Therefore, the soluble sodium aluminate, in the stated conditions of dilution and temperature, is a disodium dialuminium tetroxide,—

$$Al_2\begin{cases} O \\ O \\ (ONa)_2 \end{cases}$$

The equation will be:—

$$K_2Al_2(SO_4)_4+8NaOH= =Na_2Al_2O_4+K_2SO_4+3Na_2SO_4+4H_2O.$$

The greatest dilution was 1 part of the soluble sodium aluminate in 546 parts of solution; the least dilution, 1 in about 95 parts solution.

Fremy did not obtain crystals of the sodium aluminate. Tissier* obtained four different combinations, $Na_2Al_2O_4$, $Na_6Al_4O_9$, $Na_4Al_2O_5$, and $Na_6Al_2O_6$—all in some degree soluble in water, the last-named yielding sodium hydrate to alcohol. Schaffgotsch† found that one molecule of aluminium oxide, fused with sodium carbonate, expels rather more than one molecule of carbon dioxide.

II. Zinc Oxide in Alkaline Solutions.

In 1834, Laux‡ obtained crystallised potassium zinc oxide of the symmetric composition, $K_2O.ZnO$. The crystals were soluble in cold water; but boiling water caused precipitation of $K_2O(ZnO)_2$. Fremy§ obtained crystals of $K_2O(ZnO)_2$, these being decomposed by water.

Ammonium zinc oxide was crystallised by Malaguti, as he reported,‖ with nearly the composition,

$NH_3.ZnO.3H_2O$ [$NH_4OH.Zn(OH)_2.H_2O$; or $Zn(OH)(NH_2)_3H_2O$].

Weyl,¶ by dissolving zinc in aqueous ammonia, in contact with iron, obtained the product, $(NH_3)_2ZnO$. This differs only by a molecule of water from zinc diamine, $(NH_2)_2Zn$. Neither the product of Malaguti, nor that of Weyl, appears to have been wholly soluble in water, without the help of ammonia.

I have obtained some determinations** of the quantities of potassium hydrate, sodium hydrate, and ammonium hydrate, respectively required to re-dissolve their precipitates in solution of zinc salt, in certain conditions of dilution and temperature. It was found that, in all conditions, some excess of the alkali needed to dissolve the precipitate, could be neutralised by an acid before the precipitate reappeared.

At 17° C., each c.c. of a normal solution of zinc sulphate, required 8 c.c. of a normal solution of *Potassium hydrate*, to re-dissolve the precipitate at first formed. (In four trials, the numbers were, of c.c., 8·0, 8·1, 8·0, and 8·0) In taking up the excess of alkali, with semi-normal solution of sulphuric acid (each c.c. equivalent to a c.c. of the normal solution of potassium hydrate), it was found that 4 c.c. could be added before causing a precipitate. So that 4 c.c. of the KOH solution were required to retain in solution the zinc from 1 c.c. of the $ZnSO_4$ solution. The titrations with alkali and acid, then, sustain the following equations:—

(1.) $ZnSO_4+8KOH= K_2OZnO+4KOH+K_2SO_4+2H_2O.$

(2.) $K_2OZnO+4KOH+2H_2SO_4= =K_2OZnO+2K_2SO_4+4H_2O.$

The solution with excess of alkali (not titrated back with sulphuric acid) was precipitated on adding about twelve times its volume of water. A decinormal solution of zinc sulphate required, for each 10 c.c., an average of 12·6 of normal solution of potassium hydrate, to re-dissolve the precipitate; or about fifty per cent more, by reason of the dilution of the zinc solution from normal to decinormal. Decinormal solution of potassium hydrate would not redissolve the precipitate which it produced in normal solution of the zinc salt, however much was added. A solution of 16·5 grms. potassium hydrate to the litre—

$$\left(\frac{16{\cdot}5}{56{\cdot}1}\text{ normal}\right)$$

was the weakest solution that would at all re-dissolve a precipitate in the normal zinc solution. A stronger solution of potassium hydrate, 121·121 grms. to the litre, was tried, and 3·8 c.c. of this, equivalent to 8·2 c.c. of normal solution, were required to dissolve the precipitate from 1 c.c. normal solution of zinc sulphate. So it appears that dilution, as far as the "normal" standard, does not lessen the solubility of the precipitate in aqueous alkali; beyond the strength of the normal solution, dilution rapidly diminishes the solubility.

The above trials were all made at 16° to 17° C. In trials at 50° C., about three times as much of the potassium hydrate solution was required to dissolve the precipitate, as at 17°, and this was true with both normal and decinormal zinc solutions. It is well known that boiling precipitates zinc from its alkali hydrate solutions.

The sodium hydrate solution was prepared from metallic sodium and adjusted to normal strength. Of this normal solution at 17° C., 7 c.c. were needed to dissolve the precipitate made with 1 c.c. zinc sulphate normal solution. Then 3 c.c. of half normal sulphuric acid solution were added, before a precipitate resulted. Subtracting the sodium hydrate neutralised by the acid, short of re-precipitation, we have this equation (corresponding to the result with potassium hydrate)—

$$ZnSO_4+4NaOH=Na_2OZnO+2Na_2SO_4+2H_2O.$$

The solution bears dilution with 10·5 times its volume of water before precipitation, the trial being at 17° C. At 50° C. each c.c. of the normal solution of zinc sulphate took 18 c.c., and each 10 c.c. of the decinormal zinc solution took 27 c.c. of the decinormal sodium solution to redissolve the precipitate. It appears, then, that solution, under different conditions, requires somewhat less proportional excess of sodium hydrate than of potassium hydrate.

The normal solution of *ammonium hydrate* was adjusted in the burette, which was kept corked as much as possible. After the work the solution was again tested, and found not to have lost strength to an appreciable extent. Each c.c. of the normal solution of zinc sulphate took 6·6 c.c. of the normal solution of ammonia. (In four trials the results were, 6·6, 6·5, 6·6, 6·6.) Of the seminormal solution of sulphuric acid, 1·6 c.c. were added in reaching the point of precipitation. So 5 c.c. of the ammonia solution remain united with the zinc oxide and sulphuric acid of 1 c.c. of the zinc solution, indicating the equation—

$$2ZnSO_4+10NH_4OH= 3(NH_4)_2O2ZnO+2(NH_4)_2SO_4+5H_2O.$$

The solution can be diluted with nine times its volume of water before precipitation. 10 c.c. of decinormal solution of zinc sulphate required an average of 10 c.c. of

* *Comptes Rendus*, 48, 627; *Jahresb. d. Chem.*, 1859, 143.
† *Pogg. Annalen*, 43, 117; "Gmelin's Handbook," 3, 320.
‡ *Ann. der Chem. und Pharm.*, 9, 165.
§ *Comptes Rendus*, 15, 1106 (1846).
‖ *Comptes Rendus*, 62, 413 (1866).
¶ *Jahresb. d. Chem.*, 1864, 165; *Pogg. Ann.*, 123, 353.
** These estimations were made by Mr. F. S. Wilson, under my direction.

normal ammonia solution to re-dissolve the precipitate. At 50° C. no more of the ammonia was required to re-dissolve the precipitate than at 17° C., a marked difference from the results with the fixed alkalies. It will be observed, a much smaller proportional excess of ammonium hydrate than of potassium or sodium hydrate is required to dissolve the precipitate.

We have, then, apparently, the following alkali-zinc oxides, intact in water solutions not too dilute:—

Di-potassium zinc oxide, of a chemical identity sustained by crystalline separation:—

$$Zn\begin{cases}OK\\OK\end{cases}$$

Di-sodium zinc oxide, less certainly individualised:—

$$Zn\begin{cases}ONa\\ONa\end{cases}$$

Di-zinc-hexammonium dioxide, inferred from the constituents of its solution:—

$$3(NH_4)_2O.2ZnO = (NH_3)_6(ZnO)_2 + 3H_2O$$

$$\begin{array}{l}Zn—O—NH_3\\ \quad\quad\quad\ NH_3\\ \quad\quad\quad\ NH_3\\ \quad\quad\quad\ NH_3\\ Zn—O—NH_3\end{array}$$

III. Silver-Ammonium Oxide in Solution.

The proportion of ammonium hydrate required to dissolve the precipitate it first forms in silver nitrate solution, at various degrees of dilution and temperature, was carefully determined.* The results show that pretty nearly two molecules of ammonium hydrate are, in every case, required for one molecule of silver nitrate, in attaining solution of the precipitate. Conditions of dilution and temperatures do not materially influence the result. The variations in results were greater than those found with corresponding determinations for fixed alkalies, possibly owing to vaporisation of ammonia, in spite of precautions. The detailed results are given below, as well as the particulars of the work. It is impossible to say how much influence is exercised by the ammonium nitrate in dissolving the silver oxide. If this influence be disregarded, the action of the ammonia is represented by the following equation:—

$$2AgNO_3 + 4NH_4OH = (NH_3Ag)_2O + 2NH_4NO_3 + 3H_2O.$$

The hypothesis of silver-ammonium oxide,—

$$\begin{cases}NH_3Ag\\NH_3Ag\end{cases}O,$$

is adopted as more in accord with known compounds than the silver and ammonium oxide, NH_4AgO, or silver-ammonium hydrate, NH_3AgOH.

The solutions of silver nitrate used were the normal and decinormal. The ammonia solutions were of indefinite strength, one near normal and one near decinormal, and their exact strength was found after each trial, or set of trials, by titrating with solutions of oxalic acid, normal and decinormal. The burette was kept closed as far as possible by rubber tube and pinch at the top. Five beakers were set, each with 1 c.c. of the normal solution of silver nitrate, and one beaker for titration with normal solution of oxalic acid. In the first estimation there were required to dissolve the silver precipitate, respectively, 1·6, 1·7, 1·5, 1·6 c.c. of the nearly normal solution of ammonia, and 5 c.c. of the ammonia solution required 6·5 c.c. of normal solution of oxalic acid. Then—

$$5·0 : 6·5 :: 1·6 \text{ (average of five)} : x = 2·08.$$

In like manner other estimations were made, mostly starting with 2 c.c. silver solution, giving results as follows:—

	C.c.		C.c.	
1. 5 trials	1	normal Ag sol. requires	2·08	normal NH_3 sol.
2. 5 „	1	„ „ „	1·95	„ „
3. 5 „	1	„ „ „	1·90	„ „
4. 5 „	1	„ „ „	1·95	„ „
5. 5 „	1	decinormal „ „	2·23	decinormal „
6. 5 „	1	„ „ „	2·24	„ „

The 1st set of trials were made at 30° C.; the 2nd, at 23° C.; the 3rd, at 24° C.; the 4th, at 23° C.; the 5th, at 30° C.; the 6th, not noted.

The silver-ammonium solutions were not precipitated by normal or decinormal solution of nitric acid at any point of its addition, and were not precipitated by decinormal solution of sulphuric acid until the neutral reaction was reached.

* All of these determinations were carried out with much care and discrimination by Mr. D. E. Osborne.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, April 6, 1880.

J. P. Joule, D.C.L., LL.D., F.R.S., &c., President, in the Chair.

E. W. Binney, F.R.S., F.G.S., said that in vols. xvi. and xviii. of the *Proceedings* of the Society he had given accounts of a *Eucalyptus globulus* which he had planted in his garden near the sea at Douglas, Isle of Man. During the winter of 1878 and 1879 it suffered in its foliage and young branches to a considerable extent; but during the past winter, although the temperature of the month of December, in the Isle of Man, was lower than that of the same month in 1878, the tree has almost escaped damage, and is at the present time growing vigorously and giving out a strong odour throughout the surrounding air. It has not grown much in height during the last two years, as it is now considerably higher than the sea wall near to which it grows, but it has much increased in the diameter of its stem. Up to this time it has shown no signs of flowering.

"*Note on modified Chlorophyll from the Leaves of* Eucalyptus globulus," by Edward Schunck, Ph.D., F.R.S.

Whoever has seen the *Eucalyptus globulus* growing must have been struck with the peculiar glaucous appearance of the foliage, such as few European plants show. I thought it would be of interest to ascertain whether this peculiar appearance might be in any degree due to the state in which the chlorophyll exists in the leaves. A very simple experiment, however, sufficed to prove that the peculiar appearance referred to is owing to a covering of fatty matter, such as is seen on fresh plums and other fruit, which, though exceedingly thin, is sufficient to modify the green colour of the leaf. On washing the leaves with a little ether the film of fatty matter disappears instantly, the leaves then appearing green like ordinary leaves. The ether leaves on evaporation a white semi-crystalline fatty residue, which melts at a temperature much lower than that of boiling water, and is partly soluble in dilute alkaline lye boiling, so that it probably consists in part of some fatty acid. The leaves after washing with ether do not differ in appearance from other leaves. The alcoholic and ethereal extracts of these leaves show, however, a peculiarity, as regards the chlorophyll contained in them, which I have not observed in any other green leaf extract, though the same thing may have been observed by others and recorded in one of the numerous memoirs on chlorophyll, the whole of which I do not profess to have read. If a few of the smallest and latest-formed Eucalyptus leaves from the tips of the branches are extracted with ether a green solution is obtained which

show the usual absorption-bands of ordinary unchanged chlorophyll. If, however, a little of the extract contained in a tightly-corked test-tube be kept in a dark cupboard for several days, it gradually acquires a yellowish tint, and now shows absorption-bands coinciding with those of so-called "acid chlorophyll," that is, of the modification which is produced at once by adding a few drops of an acid, such as acetic acid, to a solution of ordinary chlorophyll. The change in the spectrum produced by the action of acids consists in the disappearance of the chlorophyll band III., and the intensification of bands II. and IV., which now more nearly approach band I. in strength. An alcoholic extract of more fully developed, but still quite fresh and vigorous leaves (I took for the purpose the pair next in order of development to those at the summit of the branch), showed the ordinary chlorophyll bands, though on attentive examination band IV. was found to be a little more defined than usual. After being kept in the dark, however, for twenty-four hours, the extract became yellowish, and now showed the bands of "acid chlorophyll" as distinctly as did the ethereal extract after several days. An alcoholic extract of fresh grass after being kept in the dark for several days had not changed in the least, and still showed the ordinary chlorophyll bands. On exposing the extract of grass for a few hours to sunlight it gradually lost its green colour, became of a pale yellow, and then showed hardly a trace of absorption-bands, the band I. being only just discernible. On exposing the alcoholic Eucalyptus extract, after being kept in the dark for twenty-four hours, to sunlight, it also became much paler in colour; but the bands I., II., and IV. *a* were quite as distinct as before insolation, and in addition to these the broad band IV. *b*, between the lines E and F of the spectrum, which also belongs to the so-called "acid chlorophyll," now came out very neatly, it having been previously invisible on account of the great obscurity in that part of the spectrum. It appears, then, that an alcoholic or ethereal extract of Eucalyptus leaves undergoes, even in the absence of light, a change whereby the normal chlorophyll contained in it is converted into a substance which shows the same absorption-bands as, and is perhaps identical with, "acid chlorophyll." I am inclined to attribute the change which takes place to the large amount of essential oil contained in the leaves, and consequently in the extracts. Essential oils, it is well known, convert inactive oxygen into ozone, and ozone, according to Gerland, produces a change in alcoholic solutions of chlorophyll similar to the one I have described, whilst under the same conditions ordinary oxygen is without effect, which Sachsse seeks to explain by supposing that the ozone in Gerland's experiments led to the formation of some organic acid which reacted on and modified the chlorophyll. Fresh Eucalyptus leaves contain no acid soluble in water, for a watery decoction of the leaves does not redden blue litmus-paper, and remains neutral even on exposure to the air for some days; but the alcoholic extract shows after insolation a marked acid reaction. It would be interesting to ascertain whether alcoholic extracts of other leaves containing much essential oil behave in the same manner as Eucalyptus extract. I made the experiment with leaves from the orange tree, in which, as in Eucalyptus leaves, numerous oil-cells may be seen under a lens; but the alcoholic extract, on being kept for several days in the dark, remained unchanged. After insolation it differed slightly from an extract of grass made at the same time, and exposed along with it to sunlight, bands I. and IV. *a* remaining visible, while the corresponding bands of the grass extract had disappeared.

"*On the Chemical Composition of the Ink on Letters and Documents as Evidence in Legal Cases*," by William Thomson, F.R.S.E.

The ideas which I propose to bring before you are not entirely new. They are based on the examination of the ink on letters and documents as a valuable mode of investigation in civil and criminal law cases.

It frequently happens that circumstantial evidence of a very simple character, which is often overlooked, might occasionally have the effect of conclusively proving the innocence or guilt of an accused person, or of pointing in some definite direction towards tracing the culprit. In civil legal cases the same class of evidence may prove equally useful.

If, for instance, a person be murdered on the highway, and any weapon or instrument found with which the deed had been committed, it is needless to say that such implement would be carefully examined for name, mark, or number, or in fact any peculiarity by which it may be traced to its former owner. Again, recent foot-prints in the snow or in soft clay often present sufficient individuality about them to make them useful in the detection of crime, and these means are usually employed. Seldom, however, is it supposed that a common substance such as the ink used in writing a letter or document has any special individuality about it. All ordinary inks are black or nearly so, yet it is conceivable that the name and address of the writer of an anonymous letter may, under a given combination of circumstances, be contained within the black fluid with which the letter was written. If, then, a murderer has left his trace behind him in the shape of paper and ink, it seems to me not improbable that, by a judicious use of the latter, some important information may be obtained respecting him which may ultimately lead to his capture. Some years ago the information obtainable by the examination of the ink on papers or documents would probably have been comparatively insignificant, owing to the fact that the number of different kinds of ink in the market at that time would be small, and the modes of preparation of the ink simple, and the materials used not specially subject to variation. At the present day, however, a large number of different articles, many of which are subject to variation, are employed in the manufacture of ink, and a large number of different inks are in general use; and from these reasons the testimony capable of being obtained by the chemical examination of the ink on letters or documents at the present time may, in some cases, prove to be of the greatest importance.

The reagents which I have found to act best in the testing of the ink on papers are nine, viz.—

1. Dilute sulphuric acid.
2. Strong hydrochloric acid.
3. Slightly diluted nitric acid.
4. Sulphurous acid solution.
5. Caustic soda solution.
6. Cold saturated solution of oxalic acid.
7. Solution of bleaching-powder.
8. Solution of protochloride of tin.
9. Solution of perchloride of tin.

The method which I have adopted in applying these reagents is to moisten one or more strokes or letters of the writing with each reagent, and then to absorb by blotting-paper the excess of fluid a few seconds afterwards.

By thus treating the ink on different envelopes lately sent to me I find they give very diverse results: with sulphuric acid, for instance, the black colours of the different inks are changed, in some to bright crimson, in others to deep red, whilst some become blue, green, violet, and grey of different shades, and some remain practically unaltered; and when, as sometimes happens, the same or nearly the same colours are produced in two different inks by one reagent, the colours produced by another are very different, thus showing clearly that the letters were not written by the same inks.

The same kind of ink, sold by the same maker, but made at different times, also varies more or less in its behaviour with the reagents, as shown by the comparisons of three samples of Lyon's ink, sold in small penny bottles, which were bought at different places.

Differences between inks which give nearly the same reactions may sometimes be observed by noticing the lengths of time which the reagents require to bring about the ultimate changes, and by the shades of colour through

which the ink passes after applying each reagent. Changes also continue to go on gradually for days and weeks after the reagents have been applied. The colours and shades of the same colour can be much more distinctly seen by the aid of a good pocket lens.

It is evident that if two persons use ink made by the same maker, at the same time, the reactions would be precisely similar; but it is easy to understand that after such ink has been in use for some time, owing to the different habits of the users, each may acquire a distinct individuality. One, for instance, may have been more exposed to the air or the direct sunlight than the other, and some of the colouring matters present may thus have been more or less altered or destroyed. One person may have a habit of leaving his steel pen in the fluid, so that some of the iron may be dissolved, thus altering the character of the ink, whilst the other may not do so, or may employ a quill in writing. Again, some persons may allow their inks to dry up to a certain extent, and then add to them any fluid which may be at hand, such as tea, coffee, wine, beer, water, &c., each of which would alter the character of the writing fluid, whilst others may use mixtures of two or more different inks, in different and characteristic proportions. One can therefore understand that many persons may have in their ink-bottles fluids which are so peculiar in chemical composition that they may have as much individuality about them, when treated with reagents, as the faces of their owners. I have tested the same ink on different kinds of paper, and the resulting shades of colour produced were identical in each case.

To make use of this mode of investigation it would be necessary to get the ink or inks used by a suspected person, or preferably some writing made by him at or about the same time as any letter or document in question, and test the two side by side with each other. The resulting shades of colours may agree precisely, and may thus tell strongly against the suspected person, or they may differ very much, and so point towards exonerating him.

A case lately occurred in which the expert M. Chabot was called, and gave evidence to the effect that the handwriting in a certain libellous letter was that of the person who was indicted as the writer of it. As a witness for the defence, another person came forward and swore that he was the writer of the letter in question, and on that evidence the case was dismissed. One can, however, under some circumstances, understand that a suspicion of such a witness having perjured himself may be justifiable, and such a suspicion may possibly be removed from an innocent person by his producing for chemical examination a paper written about the same time and with the same ink as that said to have been used in writing the letter in question.

I have arranged on two sheets of paper the writings on envelopes of fifty different persons, lately sent to me. One sheet contains twenty-four, written in Manchester and the suburbs, and the other contains twenty-six, from London and the provinces; and from a minute inspection of these it will be observed that most of them are very different from each other, whilst no two give exactly similar shades of colour with all the different reagents.

NOTICES OF BOOKS.

An Introduction to the Study of Chemistry, specially designed for Medical and Pharmaceutical Students. By A. P. Luff. London. J. and A. Churchill.

We have here a work which, as we are informed in the p eface, is "not a manual nor even a manualette of chemistry," but is intended for study "previous to working at a manual of chemistry." The author's object has been to give "the elementary principles of the science, the exposition of its laws, the *modus operandi* in the construction of chemical formulæ, and the writing out of equations." Accordingly he gives an account of the three forms of matter, of latent heat, of the distinction between mixtures and chemical compounds, and the characters of chemical attraction. He then passes over to the elements and their compounds, to metals and non-metals, the physical conditions of the elements, symbols, the atomic theory, atomic weights, the hypothesis of Avogadro and Ampère, atomicity, &c. All these subjects are discussed briefly, of course, but clearly and in such a manner that no justifiable exception can be taken to the expositions given. It would indeed be strange if in treating subjects upon which there is such general accord amongst chemists a man of Mr. Luff's standing and experience had been guilty of any inaccuracy or error; but without seeking to draw any invidious comparisons, it seems to us that we have seen all these questions dealt with quite as simply, quite as clearly and accurately, in some of the very numerous chemical manuals and manualettes which are in the hands of students. In the author's concluding advice to his readers he remarks, very truly—"An elementary knowledge of the various branches of physics is indispensable as a preliminary to the study of chemistry; their exposition in this work was, however, *rendered unnecessary by the numerous books on physics already written.*" Does not the author, in the words we have italicised, substantially cut away the ground from under his own feet? For if works on physics are numerous, introductory treatises on chemistry are not less so. Indeed, without any special or exclusive reference to the work before us, we would ask professors of chemistry seriously to consider what good end is to be gained by the indefinite reproduction of books, one of which can scarcely claim any very decisive superiority over others.

Handbook of the Rational Utilisation, Recovery, and Working-up of Residual Matters of every kind. (Handbuch der rationellen Verwerthung Weidergewinnung und Verarbeitung von Abfall stoffen jeder Art.) By Dr. Theodor Koller. With 22 Illustrations. Vienna, Pesth, and Leipzig: Hartleben.

The utilisation of waste products has been for years a favourite subject with technologists, especially since coal-tar has proved itself under judicious scientific treatment such a mine of valuable products. The appearance of a work like the present is therefore quite in accordance with the spirit of the age, especially as there prevail very crude notions as to what may and what may not be profitably extracted from refuse. The author has attempted to select from a superfluity of materials only such processes as the practical man may apply with advantage—a task which he recognises as difficult. Such a work, to be really valuable, should contain nothing but what will readily approve itself on a working scale, and nothing which is already thoroughly familiar to manufacturers and technologists. We are bound, however, to declare that the book before us sins greatly in the second respect. The first section on the production of ammonia contains scarcely a trace of what is not well known to manufacturing chemists. The utilisation of the residues from the preparation of coal-tar colours—a subject on which the reader might expect important instructions—is dispatched in three-and-a-half small pages, two-and-a-half of which are devoted to the recovery of arsenic from magenta residues. Little more satisfactory is the treatment of brewery residues. Save the yeast, which is to be converted into cakes for sale to bakers, the advice given is to employ the refuse for feeding cattle and for composts—all which, we submit, is already in general practice.

The section on blood and the other waste-products of slaughter-houses is very much more satisfactory. Dr. Koller describes the preparation of blood-albumen, blood-charcoal, Dippel's animal oil, butyric acid and its derivatives, fatty matter, glue, Campe's "blood-poudrette" (obtained from the clot after removal of the albumen), does

not seem to us a very happy mixture. To the pulverised clot are added dried human excrement and ground "knoppern"—an inferior kind of gall-nuts, from which the tannin has doubtless been already extracted. Why not use superphosphate? The author points out that dried blood as a plastic material has been superseded by certain preparations of cellulose. It may, perhaps, slightly nauseate the public to learn that certain admired artificial fruit-flavours—such as pineapple ether, apricot-ether, strawberry-ether, &c.—derive their origin from the residues of the slaughter-house.

The shells of the cacao-bean are recommended as the source of a brown pigment. We fear that in England they generally find their way into the stomach of the public in the guise of cocoa and chocolate.

The uses to which iron slags may be put are the preparation of slag-wool, bricks, glass, and certain salts, including sulphate of alumina.

Sewage is very slightly touched upon, but one of the processes of General Scott is described in such a manner that he appears as having devised the process of treatment with lime along with salts of iron and aluminium.

Under the title "Utilisation of Waste Matters for the Production of Colours" we find an account of the so-called patent dyes of Croissant and Bretonnière, otherwise known as "cachou de Lavalle." These dyes have not proved very successful, and their manufacture has been abandoned by several firms who had taken it up.

The brief chapter on the utilisation of the waste-waters of dye works contains a notice of the patent of Higgin and Stenhouse for recovering arsenic and phosphoric acids, which have been used in dung-substitutes, and of that of Remmer's for precipitating alizarin and purpurin from the rinsings of Turkey-red works.

In the section on treacle and "vinasses" we find a notice of the recent invention of Camille Vincent, but the application of the methyl chloride obtained by his process for the extraction of perfumes from flowers has escaped mention.

The production of oxalic acid from the waste of parchment paper is regarded as hopeful, since the resulting crystals will not be contaminated with the colouring matters which are formed by the action of alkalies upon the sawdust of hard woods.

Petroleum residues as a source for the production of aniline, alizarine, &c., as shown in the researches of Lettny, are slightly touched upon.

The various known processes for recovering tin from tinners' waste are described at considerable length.

As a whole the work can scarcely be pronounced satisfactory. The statements advanced are indeed trusworthy, and there is little of that confusion which we have met with in another book on the same subject. But the various processes mentioned are, as a rule, described in a slight and sketchy manner. Much of the information given is merely obtained from well-known and public sources, such as the specifications of patents and from such works as Muspratt's "Chemistry." There are few suggestive hints and very few traces of private and special observation or inquiry in the various branches of industry concerned.

CORRESPONDENCE.

TIN IN PRESERVED FRUITS.

To the Editor of the Chemical News.

Sir,—Has tin any action, deleterious or otherwise, when taken into the human system? I can scarcely imagine that it is particularly beneficial in large quantities. I have found that the juice contained in tins of preserved pine-apple has a very corrosive action upon the lining of the containing vessel. I first noticed that, as the contents were consumed, a ring was formed on the tin at each successive level of the juice. Upon testing it I found abundance of a stannous salt present, which speedily oxidised to stannic when the juice was filtered. There was no lead present, but a trace of iron.

Thinking that perhaps the tin was not attacked till it was opened, and air had access, I punctured another tin and poured off the juice; but this also contained the same metal, and upon opening there was an encrusted ring where the level of the juice had stood.

I also tested the juice from a tin of apricots, and found the same contamination, but to a less extent. The juice of the latter was less acid and much thicker with sugar than that of the former.—I am, &c.,

A. Percy Smith.

Rugby, July 8, 1880.

THE NEW PATENT BILL.

To the Editor of the Chemical News.

Sir,—If the MS. of my last week's letter had been more legible you would have made me say that "the volumes" (not "the roll") "of special class abridgments should all be completed up to within a year of date," by the Patent Office authorities.

As a practical comment upon this recommendation, it should be noted that the only volume yet issued of abridgments of chemical patents is the one so well known to and consulted by many of your readers—"Abridgments: Acids, Alkalies, Oxides, and Salts. A.D. 1622—1866." How invaluable to chemical inventors would have been a continuous issue of these chemical abridgments indexed up to present date!

If my previous letter had not been so long I would have gone on to show that the large revenue derivable from a patent tax, commencing at £1 per annum, but increasing £1 with every year of its twenty-one years' duration, would maintain a staff of technical men not only to prepare abridgments of British patents, but to ascertain exactly what had been patented in foreign countries, the abridgments in both cases being issued in a weekly publication fully and continuously indexed to date.

The former weekly publication of indexed abridgments proved the entire practicability of the plan, if the Commissioners of Patents would only employ a sufficient number of experts to prepare the abridgments.—I am, &c.,

Frank.

HYDROGEN PEROXIDE AND OZONE.

To the Editor of the Chemical News.

Sir,—Your last issue has made me acquainted with the further experiments of Prof. A. R. Leeds upon the atmospheric oxidation of phosphorus.

Will you allow me to state that, having early in this year commenced a similar study, I was able to announce at the meeting of the Chemical Society, on June 3rd last, the following facts:—

1. Both ozone and peroxide of hydrogen are formed by the action of air upon phosphorus in the presence of water.
2. The formation of ozone is substantiated by the observations that the active substance in the gas is destroyed at 300° C., and is totally absorbed by oil of turpentine.
3. The ozone is not decomposed by passing it through a 10-volume solution of peroxide of hydrogen.
4. The peroxide of hydrogen produced bears a greater relation to the ozone formed than stated by Prof. Leeds. That gentleman estimated the peroxide "on the assumption that it is completely absorbed by the washing water," whereas I find it chiefly resides *in the water in which the phosphorus is oxidised.*

At an early meeting of the Chemical Society, next session, I hope to communicate the details of these and other experiments with regard to processes of slow oxidation. Meantime the publication of this note will much oblige.—I am, &c.,

C. T. KINGZETT.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 25, June 21, 1880.

Effects of the Reversal of Photographic Images by the Prolongation of Luminous Action.—J. Jamin.—Photographic images may be reversed, and pass from a negative to a positive by the prolonged action of the light to which they owe their origin. This reversal is produced most readily in images of the sun on account of its enormous radiant power. But other reversals are possible, and even easy. Thus, besides solar images of 0·10 metre in diameter showing the sun with a white disc and black spots, the author has obtained landscapes, presenting the objects as they are. The time of exposure is from one to three hours. He has also produced counter types of the same nature as the original type; positive, if the type is positive, and negative if it is negative. In these photographs the same spectral rays which give at first the negative image effect its conversion into a positive image.

Formation-heat of the Oxides of Nitrogen and those of Sulphur.—M. Berthelot.—The author discusses the agreements and the differences between his thermochemical determinations and those of Prof. Thomsen. For the formation-heat of SO_2 he gives as the mean of three determinations +34 63. This result applies equally to octahedral, prismatic, and insoluble sulphur.

Luminous Spectrum of Water Vapour.—Dr. Huggins.—The author gives a table of the wave-lengths of the principal rays of the luminous spectrum of water vapour.

Proportion of Carbonic Acid in the Air: in Reply to M. Marié Davy.—J. Reiset.—The writer maintains the accuracy of his results, asserting that he has found a variation between the extreme proportions of 7·1 per 100,000. The minimum, 27·99, was found July 10, 1873, in a field of barley and lucerne. The maximum, 35 16, occurred at Paris, January 27, 1879.

New Meteoric Mineral, with Information on the Fall of Meteorites in Iowa, May, 1879.—J. Lawrence Smith.—The meteorite in question, to which Prof. Smith gives the name of peckhamite, is—

Silica	49·59
Ferrous oxide	17·01
Magnesia	32·51
	99·11

At least 3000 fragments of the Iowa meteorite have been discovered, their joint weight amounting to 30 kilos. They consist of nickel-iron, with very small quantities of earthy matter.

Certain Modifications in the Construction of the Bunsen Lamp and of Mono-chromatic Lamps.—A. Terquem.—The author sums up the following defects in the Bunsen burner. The flame is hollow in almost the whole of its length, and the temperature is not uniform. The entrance of air can only be increased within the limits permitted by the total opening of the vents at the base of the tube. If the air enters in a great quantity the flame is shortened, the hollow cone contracts, and the green tint of hydrocarbons burning with an excess of air, but the flame is very unsteady, and the ignition is easily communicated to the jet which introduces the gas. The same accident happens if the pressure of gas is weak, and can only be avoided by partially closing the vents to increase the draught. In the author's improved lamp there are no side openings; the air enters between the foot of the lamp and the bottom of the tube, which can be raised or lowered at pleasure, 6 to 7 m.m. being sufficient for admitting the largest quantity of air necessary. The shortening of the hollow cone and the combustion of the gas at the base of the flame are thus easily effected. To avoid the oscillations of the flame and the ignition of the gas at the inferior aperture ("striking down"), the inventor places at the summit of the tube, two small vertical plates at right angles to each other, dividing the exit aperture into four parts. In place of the hollow cone there are then four smaller cones. The author then gives an analysis of the products of combustion. A very pure and intense mono-chromatic light may be obtained by placing a bead of sodium chloride in the flame of the lamp thus modified.

Etherification of Hydrobromic Acid.—A. Villiers.—The following results are arrived at:—The limit of etherification is not equal to that corresponding to the organic acids. The limit is not fixed, but rises with the temperature. The etherification ceases completely in mixtures containing a certain proportion of water. The limit of dilution beyond which the etherification cases is not fixed, and rises with the temperature. The two latter facts may be explained by the existence of definite hydrates of hydrobromic acid, and by the dissociation of these hydrates under the action of an elevated temperature.

A Hydrated Methyl Iodide.—M. de Forcrand.—The compound obtained has the composition C_2H_3I,HO. The author has prepared similar hydrates of chloroform, ethyl bromide, and ethyl iodide.

The Artificial Reproduction of Analcime.—A. de Schulten.—This mineral has been reproduced by heating a solution of sodium silicate along with aluminous glass to 180° to 190° in a closed vessel. The operation lasts eighteen hours. The product thus obtained agrees with the natural mineral in its optical and chemical characters.

Biedermann's Central-Blatt für Agrikultur-Chemie. February, 1880.

The Reversion of Phosphates and the Behaviour of Phosphoric Acid in the Soil.—H Joulie, H. Albert, and Dr. Vollbrecht.—An examination of the fact that a part of the phosphoric acid in superphosphates originally soluble in ammonium citrate becomes gradually insoluble. The authors incline to the opinion that finely-ground phosphates, or phosphates from which only one-third of their lime has been withdrawn by means of sulphuric acid, give a better result when composted with farm-yard manure, peat earth, &c., than ordinary superphosphates. The great proportion of sulphate of lime in superphosphates may easily lead to undes red results.

Agricultural Action of Reverted Phosphoric Acid and Neutral Phosphate of Lime.—Prof. A. Petermann, Dr. M. Fleischer, Dr. E. Wein, and Dr. de Leeuw.—On these questions there is still much uncertainty. Aluminic and iron phosphates seemed in some experiments to have a more beneficial action than tribasic lime phosphate. On light, calcareous soils reverted phosphoric acid is found equal, if not superior, to such as is soluble in water.

Digestibility and Nutritive Value of the Locust Bean or Carob.—Dr. H. Weiske.—In experiments made upon sheep it was found that the carobs, though eagerly eaten, depressed the digestive power of the animals.

Determination of the Commercial Value of Grai .—Prof. E. Wollny.—The specific gravity of grain is of less value than the absolute weight and size of the individual grains.

Injury to Vegetation from Acid Gases.—Dr. J. Schrœder.—The action of sulphurous acid is always intensified by heat, light, and moisture. Sulphurous acid is always much more destructive than hydrochloric acid, or than an equivalent proportion of sulphuric acid.

Soft and Hard Water in Brewing.—E. R. Southly.—The author pronounces that the value of calcium and magnesium sulphates as constituents of water depends on their promoting the clarification of beer, and on their antiseptic action.

Correspondenz-Blatt des Vereines Analytischer Chemiker.
No. 4, February 15, 1880.

Arsenophobia.—Dr. Ulex, of Hamburg, complains of the exaggerated and sensational outcry which is being raised concerning the alleged presence of arsenic in textile fabrics, paper-hangings, &c.

Modification of Classen's Apparatus for Determining Carbonic Acid in Mineral Waters.—Dr. W. Borchers.—Not capable of reproduction without the accompanying illustrations.

Determination of Glycerin in Beer.—V. Griessmayer.—100 c.c. of beer are slowly evaporated in a flat capsule on the water-bath at 65° to 75°; after expulsion of the carbonic acid 5 grms. magnesic hydrate are added, and the mixture is often stirred with a flat rod, so as to yield finally a homogeneous tough semifluid mass. The evaporation is not pushed to complete dryness. The capsule is then withdrawn from the water-bath, 50 c.c. of absolute alcohol are added, and the mass with the stirrer is digested, finally decanting into a large beaker. The residue is stirred up with 20 c.c. of absolute alcohol, and filtered. To the mixed liquids there are now poured, with constant stirring, 300 to 350 c.c. of absolute ether, when a voluminous flocculent deposit of parapepton and maltose is formed. The whole is filtered, washed with a little ether-alcohol (3 : 1), and the filtrate is exposed to spontaneous evaporation. The alcoholic liquid is then placed in a glass capsule, evaporated on the water-bath to the consistence of a syrup, and placed in an exsiccator connected with a water air-pump, so as to admit of rapid exhaustion. After twenty-four hours the capsule is removed, digested with 15 to 20 c.c. absolute alcohol, filtered through a very small filter into a tared glass capsule, again evaporated down on the water-bath, placed in the exsiccator, and weighed after twelve hours.

Hofmann's Eupittonic Acid as a Volumetric Indicator.—Paper saturated with an alcoholic solution of eupittonic acid indicates 1 part of caustic soda in 89,000 to 90,000 parts of water, whilst the best litmus paper does not go beyond 1 part in 60,000.

Journal für Praktische Chemie.
Nos. 4, 5, and 6, 1880.

On Cyanamide.—Dr. G. Prätorius Seidler.—The oxyguanidin hydrochlorate formed from hydroxylamin hydrochlorate and cyanamide has neither been obtained as such, nor as a free base, but its platinum double salt has been prepared. All further attempts were frustrated by the instability of this salt. It was found practicable to obtain cyanamides with acid radicles by the action of hydrated acids upon cyanamide. The dehydrating action of cyanamide is sufficiently energetic to decompose formic acid into carbonic oxide and water, which latter converts the cyanamide into urea. This experiment proves at the same time, that only water which is becoming chemically free, is capable of converting cyanamide into urea; as if steeped in water for a length of time it yields not urea, but dicyandiamide. The results obtained by the action of cyanamide upon lactic and salicylic acids are similar. With phenol, the products are not urea and the ethyl-ether of phenol, but dicyandiamide. With thiacetic acid the results are sulpho-urea and acetyl-sulph-urea.

Action of Phenols upon Halogen-substituted Fatty Acids.—Dr. L. Laarbach.—Phenol and phenoloid bodies act upon halogen-substituted fatty acids in presence of soda-lye in such a manner that the oxy (phenol, &c.) radicles are substituted for the halogen atoms. New acids of great permanence are thus produced, the oxyphenyl-propionic, the oxythymyl-acetic and the oxyeugenyl-acetic. The phenoxacetic acid of W. Heintz is to be regarded as the first member of this series. Bibasic phenols, such as orcin, act in an analogous manner.

On the Plato-iodo-nitrates.—L. F. Nilson.—This paper does not admit of useful abstraction.

Alleged Conversion of Albumen into Fat during the Ripening of Roquefort Cheese.—Nadina Sieber.—The author shows that no such change takes place. A part of the albumen is decomposed into leucin, tyrosin, volatile fatty acids, and ammonia.

On Salireton.—P. Giacosa.—Salireton is a crystalline body, obtained by heating saligenin to 100° with equal equivalents of glycerin, or with methylal, and in less abundance with mannite.

Behaviour of the Sugars with Alkaline Solutions of Silver and Mercury.—Dr. F. Soxhlet.—This paper does not admit of useful abstraction.

Verhandlungen des Vereins zur Beforderung des Gewerbfleisses. No. 2, February, 1880.

Lithium Glass.—Dr. Otto Schott.—Glasses composed of a mixture of soda and lithia show a great power of resisting acids, and do not differ essentially from known kinds of crown glass, either in the absolute value of the refraction or in the total dispersion. Lithium in glass does not serve as a substitute for the alkalies, but for the alkaline earths.

Processes of Griessmayer and Lallieu for Determining Glycerin in Beer.—Prof. C. Liebermann.—The method of Lallieu has a certain value if it is required rapidly to prove the absence of glycerin in beer. It can be used for an approximate quantitative determination only in the exceptional cases, when it is certain that the impurity is nothing but glycerin.

Gazzetta Chimica Italiana.
Anno 10, Fasc. 1, 1880.

Crystallographic Examination of some Bodies of the Aromatic Series.—G. La Valle.—The bodies thus described are tri-bromo-benzol, bi-iodo-benzol, mono-nitro-chloro-phenol, and bi-nitro-iodo-benzol.

Further Observations on Digallic Acid.—Ugo Schiff.—A reply to the memoir (*Gazz. Chim.*, 9, p. 327 in which the existence of artificial tannic acid is called in question.

Contribution to the Chemical History of Stereocaulon Vesuvianum.—Prof. Michele Coppola.—Not suitable for useful abstraction.

New Method of Determining the Melting-point of Organic Bodies.—Dr. G. Roster.—The author's method, suggested by that of Terreil, is to place the substance directly upon the bulb of the thermometer, substituting for liquid baths, or for the method of heating used by Terreil, a bath of confined air.

On Podophyllin.—Prof. Icilio Guaresci.—The substance known as podophyllin is a mixture of two substances a glucoside and a resin. The glucoside is contained in the portion insoluble in ether and the resin in the soluble part. The action of melting potassa yields products belonging to the aromatic series. The portion insoluble in ether resembles in some of its characters convolvuline and the turpentine of Spirgatis.

The Meteorite of Albarello.—Pietro Maissen.—An analysis of a meteorite which fell in July, 1766.

Researches on the Yellow Incrustations of the Lava of Vesuvius, of 1631.—Arcangelo Scacchi.—An account of the substance to which the author gives the name of vesbium, and which he considers as a new metal. Vesbium forms an acid which yields with the alkalies soluble salts, but with the other metallic oxides salts soluble in water, but soluble in acids. The acid solutions of aluminium and iron vesbiates are of a green colour, which is changed by sulphuretted hydrogen to a blue. The alkaline solutions of the alkaline vesbiates are yellow, and yield with the solutions of other metallic salts precipitates of various colours. The silver salt is of a yellowish red, and the zinc vesbiate is greenish.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 18, April 29, 1880.

Adulterated Wines.—A controversy is raging between a Hungarian wine merchant and the wine growers of Dalmatia, each party accusing the other of making a fraudulent use of magenta.

Reproduction of Certain Mineral Bodies by the Superposition of Liquids of Densities and Capable of Forming with each other Insoluble Precipitates. —E. Monier.—The difference between the respective densities of the liquids must be great. The strata are not separated by parchment paper or any other porous septum. In this manner the author has obtained artificial resinite quartz by the action of aluminium sulphate upon an alkaline silicate, and has decomposed carbon disulphide by alkaline silicates.

No. 19, May 6, 1880.

The chemical matter in this number is taken from the *Berichte der Chem. Gesellschaft.*

No. 20, May 13, 1880.

Researches on the Relative Intensity of the Spectral Rays of Hydrogen and Nitrogen, with reference to the Constitution of the Nebulæ.—C. Fievez.—The spectra of the nebulæ display the rays of hydrogen and nitrogen which resist extinction longest, and warrant the supposition that these bodies are present in the nebulæ.

The Use of the Term "Indigo" by Newton, and its Relations with the Colouration of the Spectrum. —Prof. Rood.—The author contends, in common with Prof. Von Bezold, that "ultramarine" should be substituted for "indigo" as the name of a spectral colour. He shows that indigo is in reality a greenish blue, and contains a considerable element of blackness.

Bulletin de la Société Chimique de Paris,
No. 5, March 5, 1880.

Properties of Bicalcic Phosphate.—A. Millot.—This salt prepared in the cold and dried at 100° contains 5 equivs. water, and only begins to lose its crystalline water at 115°. It is completely dissolved in an hour in a sufficient quantity of ammoniacal ammonium citrate. Bicalcic phosphate with a single equivalent of water dissolves more slowly in this reagent, and the solution is only complete after a digestion of about twelve hours. A specimen of bicalcic phosphate with 5 equivs. of water preserved in a bottle for five years lost an equivalent of water, and no longer dissolved entirely in the ammoniacal citrate in an hour. The bicalcic salt loses its crystalline water, and is decomposed in boiling water. If we mix bicalcic phosphate and water, and heat to a boil, the liquid becomes acid, acid phosphate of lime dissolves, and a mixture of bi- and tri-calcic phosphate remains.

There are no other original papers in this number,

THE JOURNAL OF SCIENCE
for July (Price 1s. 6d.), includes—

The Evolution of Scientific Knowledge. By C. Lloyd Morgan.
Habits and Anatomy of the Honey-bearing Ant.. By C. Morris.
The "Laws of Emphasis and Symmetry." By J. W. Slater.
Instinct and Mind. By S. Billing.
Tuberculosis transmissible through the Meat and Milk o Animals affected with it.
Natural Science and Morality. By S. Tolver Preston.
Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.
The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.
Especial facilities or persons preparing for Government and other examinations.
Private Pupils will find every convenience.
Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.
Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

C. H. GIMINGHAM'S PATENT COMBINATION BLOWPIPE,
FOR AMATEUR & PROFESSIONAL GLASS-BLOWING, &c
AS USED IN L. CASELLA'S WORKSHOPS.

The difficulties of Glass-Blowing are reduced to a minimum by this instrument. It combines the use of the large or small flame and large Bunsen flame, the changes from one to the other being made in less than one second.
SOLE MAKER—
L. CASELLA, 147, HOLBORN BARS, LONDON, E.C.

TO ALKALI MANUFACTURERS.

The Advertiser, with many years' practical experience in large works, desires a Re-engagement as Manager or Sub-Manager. Is thoroughly conversant with the manufacture of Sulphuric and Hydrochloric Acids, Sulphate of Soda, Bleaching-powder (Weldon's and Deacon's Processes), Sulphur Recovery, Revolvers, Soda-ash, White and Cream Caustic, Soda Crystals, Bicarb., Sulphate and Muriate of Ammonia, Sal-ammoniac, &c. Well up in the management of large staffs of men and general routine of works.—Address, "Alkali," CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

WEST HAM.

TO BE LET, about 2 acres of Building Land, abutting to Channel Sea River, suitable for the erection of Factory Premises. Rent £300 per annum on Building Lease, or would be let in two or three plots. A smaller plot adjoining would be let on building lease at £80 per annum, or it would be let in two portions.—For further particulars apply to Messrs. Debenham, Tewson, and Farmer, and Bridgewater, 80, Cheapside, E.C.

TO ANILINE and Other DYE MANUFACTURERS.—To be Sold by Tender, in lots, the LEASES of the Premises known as "The Star Chemical Works," Brentford, held for a term of forty years from Michaelmas, 1853, at a nominal rent of £28 per annum; and the "Star Chemical Works," Wandsworth Bridge Road, Fulham, occupying an area of 2a. 1r. 28p., and held for a term of ninety-nine years from 24th June, 1874, at a ground rent of £115 per annum (together with certain wharfage rights on the bank of the Thames, adjoining Wandsworth Bridge). Also, the Fixed and Loose PLANT, Stock and Effects, and Goodwill of the Business now being carried on at both the before mentioned premises.—Particulars, with Forms of Tender and conditions, may be had of Messrs. Munns and Longden, Solicitors, 8, Old Jewry, E.C; of Messrs. R. Mackay and Co., Public Accountants, 3, Lothbury, E.C.; and of Messrs. Frank Lewis and Co., Auctioneers, Valuers, &c., 95, Gresham Street E.C.

Wanted, Large Quantities of Crystallised Protochloride of Iron.—Address, A Z, CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, Quotations and Samples of Sulphide of Barium. FOR SALE, Sulphate and Carbonate of Barytes. All qualities, and specially made for Chemical and Colour purposes. —T. W. Ellis, Alphington Street, Exeter.

Superior Old-Established (upwards of 100 years) Chemist and Druggist's Business FOR SALE, with immediate possession and proper introduction. Capital dwelling-house attached. Lease can be had. Incoming about £400. Owner retiring from business after 50 years successful management.—For all particulars apply to King and King, 130, Queen Street, Portsea.

GREENBANK ALKALI WORKS COMPANY (LIMITED), ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{3}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers. &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{1}{200}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

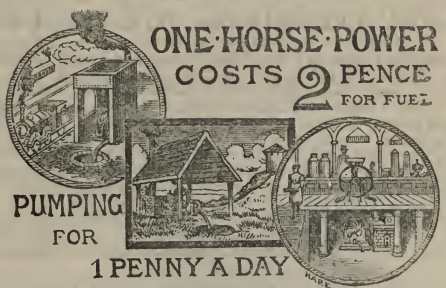
PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application. Orders for small quantities executed for Cash against Invoice.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

BAILEY'S PATENT HOT-AIR ENGINE.



Made from ¼ to 5 horse-power. 56lbs. of coke will keep a 1-horse going 12 hours. 1000 galls. of water lifted 50 feet high for a penny,

NO BOILER. NO DANGER.

Awarded Prize Medal by the chief Societies,

W. H. BAILEY & Co., Albion Works, Salford, Manchester.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

Established 1798.

ROBERT DAGLISH & CO., ENGINEERS, BOILER AND BRIDGE MAKERS, MILLWRIGHTS, BRASS AND IRON FOUNDERS.

Manufacturers of every description of Condensing, or High-pressure Blowing, Pumping, Rolling, Winding, and Patent Steam-engines, of any required power, for Irrigating, Draining, Mining, Rolling Mills, or Water Works purposes, and Manufacturers of every description of Chemical, Colliery, Copper Ore, Gold Mining, Glass, and Rock-salt Machinery.

Black-ash Revolving Furnaces of the Most Approved Type.
Bessemer Steel-Rail Plant.
Compressing-Engines for Collieries, Iron Works, and Weldon's Patent Bleaching-Powder Process.
Caustic, Chlorate, Decomposing, Nitre, Nitro-Glycerine, Iodine Potash, Sulphur, Acid, and Oxalic Pans.
Gas Producers Patent for Heating and other Purposes.
Pyrites Burners for Irish, Norwegian, and Spanish Ores of Improved Construction.
Patent Rousing Machinery for Brewers.
Retorts, Acid, Gas, Iodine, Nitric, Nitre, Nitro-Glycerine and Vitriol Refining.
Steam Superheaters improved for Oil, Tar, and Resin Refining.
Steam Sulphur Melter.
Stills for Oil, Resin, and Tar.
Wheels, Bevel, Mitre, and Spur Moulded on the Shortest Notice by Patent Machinery.
Makers of Mactear's Patent Carbonating Furnace, Jones and Walsh's Patent Sulphate of Soda Furnace, Parnell and Simpson's Patent Causticiser, and Kynaston's Patent Alum Plant.

Lists sent on Application.

Photographs, Plans, and other information supplied on receipt of Order.

ST HELEN'S ENGINE, BOILER, AND BRIDGE WORKS AND FOUNDRY, LANCASHIRE.

BISULPHIDE OF CARBON,

CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,
161 162 163, Palmerston Buildings, London, E.C

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

JESSE FISHER & SON,
Phœnix Chemical Works Ironbridge.

WILLIAM AND WILLIAM T. FIELD

MANUFACTURERS of the Celebrated STAFFORDSHIRE BLUE BRICKS, specially adapted for Chemical Plant, *i.e.*, Acid Towers, &c. Also all other kinds of Best Staffordshire Blue Bricks, Pavings, Plynths, Splays, Copings, &c. &c. Prices and samples on Application.

TESTIMONIAL.

"We have used the Blue Staffordshire Brick or Sulphuric Acid Towers, &c., manufactured by Messrs. Field, for the last fifteen years during which time they have given great satisfaction. We recommend them to the Chemical Trade, believing there is nothing better in the market."—(Signed) WILLIAM HUNT and SONS, Lea Brook Alkali Works, near Wednesbury, Staffordshire, February, 1878.

TOLL END BRICK-WORKS,
TIPTON, STAFFORDSHIRE.

ROYAL POLYTECHNIC.—Shakesperian Recitals: Scenes from "Hamlet" at 7.15 p.m. daily; and at 3.30 on Monday, Wednesday, and Saturday. Hamlet, Mr. Marlande Clarke; Ophelia, Miss H. Shea; The Queen of Denmark, Miss Eva Russell; Polonius, Mr. Heath; 1st Grave-Digger, Mr. Weatherhead. Lectures on the Phenomena of Nature, the Microscope, London, Phosphorescence, &c., &c. Ghost Entertainment, Bloncin, the Wonderful Automaton. Admission, 1s.; Reserved Stalls 3s.; may be booked at all the Libraries.

THE CHEMICAL NEWS.

VOL. XLII. No. 1078.

ON A

NEW CLASS OF COLOURING-MATTERS FROM THE PHENOLS.

By RAPHAEL MELDOLA.

LAST year Dr. O. N. Witt published a paper (*Journal Chem. Soc.*, vol. xxxv., p. 356), in which he described the action of nitroso-dimethyl-aniline on meta-toluylene-diamine, from which it appeared that the oxygen of the nitroso-group attacked the hydrogen of the methyl group in the following manner:—

$$\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!N.C_6H_4.N \;\vdots\overset{\cdots\cdots}{O+H_2}\vdots\; HC.C_6H_3(NH_2)_2 =$$

$$\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!N.C_6H_5.N = CH.C_6H_3(NH_2)_2 + OH_2.$$

At the time this research was published I was independently occupied in investigating the action of nitroso-dimethyl-aniline on phenols, and in order to eliminate the possibility of the formation of compounds built on the type of "toluylene blue," I have restricted my experiments to phenols not containing the methyl group. I have already given a description of the method employed in a preliminary note published last year (*Ber. Deut. Chem. Ges.*, 1879, p. 2065). In the formation of this new class of compounds I have since convinced myself that the oxygen of the nitroso-group *directly attacks the hydrogen of the aromatic nucleus*, as shown in the following equation:—

$$\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!N.C_6H_4.N \;\vdots\overset{\cdots\cdots}{O+H_2}\vdots\; H_5.C_{10}HO =$$

$$\begin{matrix}CH_3\\CH_3\end{matrix}\!>\!N.C_6H_4.N = \underset{\beta}{C_{10}H_5}.HO + OH_2.$$

The new compounds are splendidly crystalline violet colouring-matters, forming extremely oxidisable leuco-bases, and as their complete investigation promises to be very laborious, I have thought it of sufficient interest to record their general structure, as typified by the above β-naphthol compound, in anticipation of future work.

Atlas Works, Hackney Wick, London, E.,
July 13, 1880.

DETECTION AND DETERMINATION OF HEAVY MINERAL OILS, OF RESIN OILS, OF THE FATTY OILS, AND OF RESIN IN THE OILS OF COMMERCE.

By M. A. RÉMONT.

THE qualitative analysis ought to be preceded by an examination of the organo-leptic properties of the oil, the manner in which it behaves under the influence of heat, and of its specific gravity, which often gives useful indications. Thus, if the specific gravity of the sample is below 0·900 it certainly contains a mineral oil; if from 0·900 to 0·975, we may be in presence of the most complex mixtures; but if it is above 0·975 we have certainly an oil of resin.

We begin by treating the sample with carbon disulphide, freshly prepared, which gives a clear solution with all the oils. If oleic acid or a fatty oil has been mixed with alkali to raise its specific gravity by the formation of a portion of soap, there will appear a precipitate. In this case the liquid is filtered, and the residue is washed with carbon disulphide. It may be proved to be soap by its solubility in water, its alkalinity, and the turbidity, more or less marked, which is caused by an acid poured into the solution.

The filtrate is freed from the carbon disulphide by distillation: 1 c.c. of the residue is taken and mixed with 4 c.c. of alcohol at 85°. If solution takes place fatty acids are present, pure or mixed, and an excess of alcohol is gradually added. If after having poured in 50 c.c. the liquid is limpid, or there is produced a very slight cloud, which disappears on adding a drop of hydrochloric acid, the sample consists of oleic acid, pure or mixed with resin. If the specific gravity does not exceed 0·905 at 15° the sample consists entirely of oleic acid. If the specific gravity is higher the oleic acid contains resin. By way of confirmation the substance is examined with the polarimeter, either directly or dissolved in carbon disulphide, and if there is a deviation we may be certain of the presence of a resinous mixture.

If we find a persistent cloudiness in the alcoholic solution it is because the fatty acids contain an oil sparingly soluble in this solvent, and in so much the greater quantity as the cloud appears earlier. This very sensitive process renders it possible to detect 2 or 3 per cent of heavy mineral oil, or of resin, or fatty oil in the oleic acid known in commerce as oleine. The turbidity produced in the alcoholic liquid resolves itself in some time into little oily drops, which line the sides of the vessel, and which can be made by a shock to fall to the bottom of the tube. The volume of this residue shows approximately the proportion of insoluble matter.

The most common case is when 4 parts of alcohol do not completely dissolve 1 part of oil. A larger quantity of the latter is then taken, and agitated with an equal volume of alcohol. After settling for a time the alcoholic solution is decanted and evaporated in a capsule. The nature and the quantity of the residue serve as a clue to the nature of the mixture.

I submit the oil to the action of caustic soda, employing the method indicated by M. Dalican for the analysis of tallows. In a capsule of porcelain, or preferably of enamelled cast-iron, there are weighed about 20 grms. of oil, and heated to 100° to 110°. There is then poured in a mixture of 15 c.c. soda-lye at 36° B. and 10 c.c. of alcohol: the mixture is stirred and heated until the alcohol and the chief part of the water have disappeared. Then 150 c.c. of distilled water are added, and the boiling is kept up for half an hour, when three cases may occur:—

1. The oil, under the influence of the alkali, is merely emulsified, and on the addition of water it separates distinctly: this indicates either a mineral oil, a resin oil, or a mixture of the two. The aqueous solution is decanted off, and it is mixed with sulphuric acid. If there is no precipition, or if a mere slight cloudiness is produced, the sample is a pure mineral oil. If there is a considerable precipitate which collects in brown viscid drops giving off a strong odour of resin, and soluble in an excess of alcohol, we have a resin oil, pure or mixed. The oil is examined with the polarimeter, and if it acts upon polarised light this is a confirmation of the presence of resin oil. If the specific gravity is below 0·960 there is probably a mixture of mineral oil. Good indications may also be got by distilling it one of the oils is not in too trifling proportion. The distillation ought to be fractionated as far as possible and conducted slowly. As the resin oils boil, as a rule, at lower points than the mineral oils, it follows that in place of having specific gravities which increase with the boiling-points, as happens with the heavy mineral oils or pure resin oils, there are observed, with their mixtures, very abrupt transitions. The sample ought to be tested with stannic chloride, and if the violet colouration is not very distinct the same reagent should be applied to the

first products of distillation, since the colourable product contained in the resin oils is there chiefly met with.

2. Or there is formed by the action of caustic soda a paste-like mass of soap, which on treatment with water and boiling for some time gives a clear liquid. It is diluted with cold water and then supersaturated with an acid. The fatty acids liberated collect on the surface after decantation of the water, and if exposed to cold they crystallise. A small portion is melted in a tube at a gentle temperature, and 4 parts of alcohol at 85° are added first and afterwards an excess. Here two cases are possible :—

A. If no precipitation takes place it is because the fatty acids are pure, which shows that the oil examined is a pure fatty oil, or, which rarely happens, mixed with resin. The specific gravity of the fatty acids may here give good indications, but it cannot be taken at common temperatures, at which fatty acids are solid. They must be melted, and the specific gravity taken at a known temperature. M. Baudouin, Chemist at the Arnavon Soap Works, at Marseille, has drawn up a table of the specific gravities of the fatty acids of certain oils taken at 30°. Except those of linseed oil, which mark 0·910, those of the other fatty oils have specific gravities ranging from 0·892 to 0·900. To reduce the specific gravities of the fatty oils examined to the temperature of 30°, deduct from the density found, calculated on a litre, as many times 0·64 grm. as there are degrees below, or if the temperature is higher to add to the density found as many times 0·64 grm. as there are degrees above. If the specific gravity indicates that the neutral oil contains resin an attempt may be made to separate it, in part at least, rapidly by agitating 5 or 6 c.c. of the original oil with an equal volume of alcohol, decanting after settling, and evaporating in a capsule. There is thus obtained a solid or semi-fluid residue in case of resin. Further examination is then made with the polarimeter.

B. The fatty acids derived from the decomposition of the soap give a precipitate if treated with an excess of alcohol. If it is not re-dissolved by 1 grm. of hydrochloric acid, and if after some time it is resolved into oily drops it is due to a mineral oil or a resin oil. A fatty oil containing 10 to 15 per cent of one of these oils is completely saponified, and yields with boiling water not an emulsion, but a soap completely soluble. The turbidity should resolve itself into oily drops, for there are certain fatty acids—those, amongst others, of the oil of earth-nuts (*arachis*)—which are soluble in a small proportion of alcohol at 85°, but an excess of the alcohol precipitates a sparingly soluble portion, arachidic acid, in small flocks. These flocks may be collected on a filter, and examined as to their complete solubility in alkalies. If their melting-point is near 73° they may be attributed to the oil of earth-nuts.

3. Or, lastly, the oil, on treatment with soda, may give a paste more or less firm, which if placed in boiling water for half an hour allows oily drops to rise to the surface, which are due to a mineral oil or a resin oil. After settling for some minutes a part of the supernatant liquid is decanted and mixed with an excess of a saturated solution of common salt. There is produced a precipitate of soap, which is filtered off on cooling. The filtrate is supersaturated with an acid. If there is produced a slight turbidity, and if the liquid which was almost colourless when alkaline gives off an odour of fatty matters we have a neutral oil mixed with a non-saponifiable oil. If, on the contrary, the solution was highly coloured after filtration, and gives when acidified a flocculent precipitate of a resinous odour, the sample is a mixture containing resin. In these two cases, the components of the mixture may be recognised by means of the procedures indicated above.

Quantitative Analysis.—If it is desired to know the elements attacked by alkalies, and of those which are not, the following procedure is to be followed :—If the sample has yielded anything insoluble in carbon disulphide, it is separated as already said, and the operation is confined to the residue of the distillation. Let it be assumed that the composition of the residue is as complex as possible, containing fatty oils, mineral oils, resin oils, and solid resin.

The mixture is saponified. Into a flask closed by stopper, through which passes a long tube, are introduced 20 grms. of the oil, and a mixture of 15 c.c. of soda at 36° B., and 15 c.c. alcohol at 90 to 95 per cent. The flask is then set upon the water-bath for half an hour and is often shaken. At the end of this time the whole is poured into a funnel fitted with a tap and previously warmed, and which is left in a stove at 50° to 60° until a complete separation of the non-saponifiable oil from the alkaline liquid has taken place. The latter is then decanted into a porcelain capsule, and in its stead is poured 15 c.c. of boiling water which has served to rinse the flask. It is shaken well so as to wash the non-saponifiable matter, and decanted anew after settling. Finally, it is washed a third time with boiling water. The oil in the funnel is received into a tared capsule and weighed. As for what adheres to the sides, it is washed with a little ether, and the solution is received in another capsule, which is exposed to the air till the bulk of the ether has disappeared. It is then gently heated to expel the rest, and weighed.

The alkaline liquid is kept at a boil for some time to expel the alcohol, and after cooling it is mixed with an equal volume of a saturated solution of common salt, freed from magnesia by being boiled for a few moments with caustic soda and filtered. In this manner, the soap is precipitated in firm clots, carrying with it the last portion of non-saponifiable matter. The saline solution, after settling, is decanted by means of a pipette and neutralised with an acid. If a notable turbidity is produced, which collects in flocks, it is due to resin. The flocks are collected, dried, and weighed. The clots of soap are thrown upon a filter, washed twice with salt water, the last traces of which are removed by pressing the mass between blotting paper. The soap is then placed in a glass cylinder, moistened with about 100 c.c. of carbon disulphide recently rectified, stoppered, gently shaken at intervals three or four times, so as not to break the clots, and left to settle. After an hour or two the carbon sulphide which is coloured yellow by the dissolved oil, separates in the lower part of the cylinder. It is decanted by means of a pipette, and in its stead is added a fresh portion of the solvent. It is shaken, left to settle, decanted, and so on till the carbon sulphide runs off almost colourless. The whole is then thrown upon a filtered and washed for the last time. A portion of this last washing, if evaporated upon a watch-glass, should leave an insignificant residue.

The soap on the filter is exposed to the air till the carbon disulphide with which it is saturated has escaped.

As for the carbon disulphide solution, it is distilled gently on the water-bath. The last portions of the solvent are expelled by blowing air into the flask while placed in boiling water. When cold it is weighed.

The last portion of the non-saponifiable matter thus obtained ought to have the same appearance as the first portion. If it is less fluid it still contains a portion of soap. In this case it is again taken up in carbon disulphide at a gentle heat in presence of a few drop of water to hydrate the soap which, without this addition, would again be partially dissolved. It is then filtered and the washed soap is added to the chief mass.

The non-saponifiable oil may consist of mineral oil, resin oil, or a mixture of both. The means of detection have been given above, and I have not yet come upon a process for their separation.

The soap insoluble in carbon sulphide which lies on the filter contains resin and fatty acids combined with soda.

The separation of these substances, so similar in their properties, presents many difficulties. Several methods have been published, but none of them gives satisfactory results. That of M. Jean, one of the most recent, consists in exhausting the barium soap with ether, which ought to dissolve the resinate and leave the soaps of the fatty acids untouched. On following exactly the author's instructions, I have never been able to avoid the partial solution of the

barium oleate. I have modified the process by substituting for the ether boiling alcohol of 85 per cent, which certainly dissolves much less of the oleate, but still takes up enough to render the results inaccurate.

As far as possible the soap is separated from the filter and placed in a capsule. The filter is put back in the funnel and filled with boiling water. The solution is effected slowly and filters by degrees; it is received in the capsule where the detached portion has been already placed.

The solution of soap, after cooling is mixed with caustic soda until precipitation no longer ensues, and left to settle. All the soap of the fatty acids is deposited, drawing down with it the chief portion of the resinate, a part of which, however, remains in solution and colours the liquid strongly. The whole is filtered, the filtrate accurately neutralised with sulphuric acid; the flocks of resin deposited are received upon a tared filter which is weighed anew after washing in water and drying at a low temperature. The soap is re-dissolved in a little luke-warm water and an excess of barium chloride is poured into the solution with agitation. The clots of barytic soap are drained in a filter-pump, replaced in the capsule in which the precipitation has been effected and thoroughly dried in the water-bath or the stove. The mass is then powdered, and treated with 50 or 60 c.c. of alcohol at 85 per cent, which is kept near the boiling point, working it up with a pestle. It is left to settle for a few moments and the supernatant alcoholic liquid is then decanted into a phial. 20 to 25 c.c. of alcohol are again poured upon the residue, let boil, decanted after settling, and so on till a portion of the alkali which has been used leaves, on evaporation, scarcely any residue, which happens generally after 120 c.c. of alcohol have been used.

The alcoholic liquids are mixed and distilled till there remains only about 50 c.c. Hydrochloric acid is added to decompose the resinate, and the resin set at liberty floats in the liquids. On cooling it collects in a solid mass at the bottom of the vessel. It is thrown into a capsule, melted under water, and weighed after desiccation on the water-bath.

The residue insoluble in alcohol is treated in a similar manner to obtain the fatty acids.—*Bulletin de la Societè Chimique de Paris.*

DETERMINATION OF ASH IN COAL, AND INCINERATION IN GENERAL.

By Dr. FR. MUCK.

Incineration and an accurate determination of ash are, in many substances, attended with not inconsiderable difficulties. These may arise from the sparingly combustible nature of the bodies, as in case of anthracite or graphite; from the formation of a sparingly combustible carbon (in fusible organic substances); from the presence of certain mineral substances which impede incineration, as silicic acid, phosphates, and fusible salts; from a tendency to decrepitation observed in many vegetable matters and in all coals; from the partial volatility of various constituents of the ash, and from the chemical changes which the ash may undergo according to the degree and the duration of the heat and the supply of air.

The first three of these difficulties affect principally the rapid execution of the process, whilst the three remaining affect the composition of the ash and the accurate determination of its weight. Peat and lignite require no special precautions; they are readily inflammable and rarely cake together, often smouldering away like tinder. In true coal all the above-mentioned difficulties may occur. All varieties of coal decrepitate more or less. The losses thus occasioned may be obviated by conducting the incineration at first in covered crucibles. This, however, is inconvenient where a great number of ash determinations have to be performed simultaneously. The incinerations are sometimes performed in porcelain crucibles, where unburnt coal is rarely projected over the edge. In general, flat platinum vessels are preferred, in which the process is more rapid but the chance of loss much greater. To prevent this source of error, it is advisible to reduce the coal to a very fine powder, and above all to heat very gradually. The latter precaution, especially in case of caking-coal, prevents the formation of coke, the incineration of which requires a much higher temperature, and a very considerable outlay of time. Every "caking" coal loses this property completely if very gently heated for a moderate time, and may then be almost completely incinerated at a temperature little above the melting-point of lead.

Not every ash can be at once assumed quite free from carbon, and unburnt particles cannot be readily detected by stirring with a needle. They may readily be found on moistening the ash with alcohol, when any unburnt portions are detected not merely by their colour, but by floating on the surface. Moistening with alcohol has the additional advantage that the ash, which lies very loose, adheres afterwards more closely to the sides of the crucible, and the complete incineration is thus accelerated. Unburnt carbonaceous particles escape the eye most readily when the coal contains very little ash.

When sulphur and iron are present in large proportions prolonged or repeated ignition is often necessary to reach a constant result. The question remained how the weight of the ash might be affected by the presence of a large proportion of lime. Lime may be present in the coal itself as silicate, as sulphate, and as carbonate; not frequently as sulphate, since gypsum rarely occurs in the carboniferous strata, though it is frequently found in solution in the subterranean springs.

Calcium carbonate frequently occurs in coal, sometimes in large laminæ, and where these do not occur the presence of carbonates may be frequently observed on moistening the coal with acids. The ash of coal (Westphalian at least) never effervesces with acids, and when this occurs to the slightest extent it is partially due to sulphuretted hydrogen. This is evolved from calcium sulphide formed to a slight extent by the reduction of calcium sulphate by carbon. The evolution of sulphuretted hydrogen can be less easily ascribed to iron sulphide, which less readily escapes oxidation during incineration than calcium sulphide.

Coal ash often contains very much more lime than what is combined with sulphuric acid or present as calcium sulphide. The residual lime, along with other bases is combined with silicic acid.

Ash containing much ferric oxide may be not at all, or but slightly, red if much lime is simultaneously present, for calcium ferric silicate is colourless or yellowish, but not red. The following is the composition of a pale reddish coal-ash, which, if strongly ignited with the coal in question, melts to a vitreous slag. The ash scarcely effervesced with acids, and after being moistened with sulphuric acid and re-ignited it became red:—

Silica	32·17
Alumina	17·87
Ferric oxide	17·42
Lime	17·83
Magnesia	6·97
Sulphuric acid (saturating 4·018 lime)	5·94
Matter not determined	2·00

1·049 grms. of this ash moistened with alcohol, and then ignited for a considerable time in the muffle at a white heat, decreased to 1·0465 grms. On treatment with ammonium carbonate and gentle re-heating the ash, weighed 1·056 grms. The ash effervesced a very little more with acids; a trace of calcium carbonate had been decomposed during incineration. The practical results of the author's experiments may be stated as follows:—

1. The chemical changes during the incineration of coal

can only serve in rare and especial cases as an explanation of great differences in the determination of ashes. For instance, when coal contains very much sulphur, and at the same time very little lime. In presence of much lime the combustion-products of the sulphur are more or less completely retained, whilst if little lime is present variable amounts of sulphur are driven off.

2. In case of a thoroughly homogeneous material, *i.e.*, a finely-powdered and well-mixed average sample accurately and carefully analysed, the determinations of ash may be expected to agree to 0·1 to 0·2 per cent.

Larger differences, except in the peculiar cases just referred to, must be referred to defective work or great difference of the samples.

It is understood that the proportion of moisture must be taken into consideration. In a thoroughly air-dry coal—not lignite—the highest limit of moisture is from 1 to 2 per cent.

The platinum crucible, according to the position of the flame, may be coated with soot. This coating may be easily burnt away, but care must be taken not to wipe a sooty place, nor a place that has been sooty without carefully checking the weight of the crucible after weighing the ash. In the places where soot has been formed by the dissociation of the hydrocarbons the platinum becomes disaggregated and is coated with a black-grey deposit of finely pulverulent metal, which is easily rubbed off. The author has observed variations exceeding 8 m.grms. produced in this manner. He refers to the method of Schlösing, who places the substance to be incinerated in a platinum boat, introduces it into a combustion-tube, and distils in a current of dry carbonic acid. When the development of inflammable gases has entirely ceased a slow current of oxygen is substituted for the carbonic acid, and the incineration is completed. Decrepitating substances are previously charred in a closed crucible.

A remark becomes here necessary on the incineration of filters. A previous complete drying of the precipitate, as Bunsen has proved, is not merely a loss of time, but a disadvantage, whilst introducing the still moist precipitate into the crucible requires the application of a very gentle heat at the outset, and thus ensures the most favourable conditions for the easy and complete incineration of the filter-paper. Precipitates not washed upon the filter-pump can be readily brought to a sufficient degree of dryness if laid for a short time upon blotting-paper or unglazed earthenware.

Dry filters may be also much better incinerated after previous charring at the lowest possible temperature, than by rapid carbonisation or direct ignition in the flame. How advantageous it is to char previously very slowly may best be seen on incinerating filters, whose contents impede the complete combustion of the paper by the old process, *e.g.*, silicic acid, ammonio-magnesium phosphate, &c. Charred paper obtained by rapid heating is deep black and of a silky lustre, whilst if slowly carbonised it is brownish black, dull, and smoulders away like tinder. Charred paper of the first kind appears under the microscope perfectly amorphous, whilst the other displays the carbonaceous skeleton of the fibre.

A careful removal of precipitates from the filter—with the exception of cases like zinc and cadmium, where volatile reduction-products may be formed—is quite useless, since the errors which it was hoped to obviate are not really avoided. On incineration with the filter, wet or dry, an error due to reduction may be easily corrected, *e.g.*, in barium sulphate with sulphuric acid; in lead sulphate with nitric and sulphuric acids; in iron and copper oxides with nitric acid; in silver chloride with nitric and hydrochloric acids, &c.—*Zeitschrift für Analytische Chemie*, vol. xix., p. 131.

Occurrence of Iodine in Curaçao Guano.—H. Steffens.—In rendering this guano soluble violet vapours of iodine were evolved when the mass had reached a temperature of 110° to 120°.—*Zeitsch. f. Anal. Chem.*

THE HEAT OF THE COMSTOCK LODE.*

By JOHN A. CHURCH, E.M., Ph.D., New York City.

In May, 1878, I had the honour of presenting to this Institute, at the Chattanooga meeting, some observations upon the heat of the Comstock Lode, and since then the subject has attracted some attention and criticism, in the course of which I have observed errors of apprehension which I beg leave to correct now. Mr. John Arthur Phillips discussed it before the Geological Society, his paper being printed in the *Quarterly Journal* for August, 1879.†

His criticism is based upon that part of my paper in which I quote a number of analyses of the mine waters, to illustrate the fact that the heat does not come from the oxidation of pyrite. I pointed out that these waters contain only an insignificant proportion of sulphuric acid, and not enough to account for even one per cent of the heat observed, the calculation being based upon the oxidation of the quantity of pyrite which corresponds to the amount of sulphur in the water. Mr. Phillips endeavours to disprove my theory of kaolinisation, by applying the same reasoning and calculations to the amount of alkalies and alkaline earths dissolved in the waters. He says:—

"The average proportion of alkalies contained in the rocks of the district is 6·40 per cent, while the mean of the published analyses gives 11·30 grs. of alkalies in 58,373 grs. of mine water. It consequently follows that the 4,200,000 tons of water annually pumped out of the workings must contain 813 tons of alkalies, and that, as these are present in the rocks in the proportion of 6·40 per cent, the felspar in 12,703 tons of rock must be annually kaolinised and the whole of the felspars removed in solution.

"The amount of rock in which the felspar has been kaolinised being 12,703 tons and the number of tons of water 4,200,000, it follows that—

$$\frac{4,200,000}{12,703} = 330$$

is the number of tons of water heated by each ton of altered rock.

"In order, therefore, that one ton of rock should be enabled to heat 330 tons of water only 1° F., and if the specific heat of these rocks be taken at 0·1477, which is that of blast-furnace slags, it would require to be heated by the kaolinisation of its felspar to a temperature above that of molten gold. Consequently to raise the water 85° or to a temperature of 135°, at which it issues, the kaolinisation of the felspar in each ton of rock would require to elevate it to an extent we are unable to estimate, since there is no means of ascertaining the specific heat of bodies at such enormously high temperatures."

Mr. Phillips therefore concludes "that the kaolinisation of felspar is no more than the oxidation of pyrites, an adequate cause to account for the heat of the Comstock Lode." His criticism is, however, founded on fallacious premises. It may be possible to use the analyses of mine waters to determine the function of pyrite in the physics of the lode, because the products of the oxidation of pyrite are completely soluble, and all of the sulpuric acid produced may be expected to appear in the water, except such part as is precipitated as gypsum by the lime of the rocks. Observation showed that the quantity of sulphur removed by this precipitation is very small, and my use of the water analyses to exhibit the inadequacy of pyritic oxidation as a source of heat was, perhaps, pardonable, though it was inaccurate, for the reason that no attempt was made to compute the quantity of heat developed by the *hydration* of the sulphuric anhydride. This omission was allowed because the augument against pyritic oxida-

* A Paper read before the American Institute of Mining Engineers at the New York Meeting, February, 1880.

† A Contribution to the "History of Mineral Veins," by J. Arthur Phillips, Esq. F.G.S. *Quarterly Journal of the Geological Society* for August, 1879.

tion as a principal source of the heat did not depend on heat calculations, but on the fact which I repeatedly stated, that the rocks do not contain pyrite or precipitated ferric oxide in quantity sufficient to accouut for the heat by oxidation. The calculation based on the analyses merely gave a *measure* of this inadequacy, and showed that a cause to which 100 per cent of the heat had been ascribed, really did not account for as much as 1 per cent of it.

But the case is very different with kaolinisation. Here we are not dealing with the *least* apparent cause of heat, but with that one which observation shows to be the most extensive result of chemical action in the lode rocks. I believe my theory of heat from kaolinisation is acknowledged on all sides to be well founded as a general fact, and the only difference of opinion is upon the quantity of heat obtainable by the hydration of aluminic silicate. My critics acknowledge that where kaolinisation takes place some heat is produced, but they deny that its effects can be so remarkable as to produce the temperatures found in the Comstock.

The point which I now wish to insist upon is that pyritic oxidation and kaolinisation do not stand upon the same footing as possible sources of heat in the Comstock. Both come under the practical observation of the geologist, and while one is so limited in its quantity as to be insignificant as a factor of heat, the other is found to exist in the excessive magnitude which the student of geology sometimes encounters.

The Comstock rocks may be said to form a mass four miles long by four miles wide, and say two and a half miles thick, and so far as observation teaches us, it shows that every pound of this block has undergone alteration to some extent. A large proportion, say ten per cent, as a *minimum*, has been altered to flaking clay, while a still larger proportion has advanced so far in decomposition that alteration sets in vigorously when a gallery is opened in it, the rock "slakes" and the air of the gallery is highly heated, its atmosphere often becoming temporarily insupportable by man.

It is a mistake to suppose that the results of this extensive kaolinisation are represented in the mine waters. It is probable that much of it is accomplished by aqueous vapour, which is entirely absorbed by the rock and does not give rise to any solution. The rock is not saturated with water, but, on the contrary, analyses show that the hydration is almost everywhere incomplete.

The error in Mr. Phillips's calculation is contained in the words, "as these (the alkalies) are present in the rocks in the proportion of 6·40 per cent, the felspar in 12,703 tons of rock must be annually kaolinised and the whole of the alkalies removed in solution."

This conclusion is based upon the supposition that the result of kaolinisation at a great depth is clay free from alkalies. But that is not the case. The result is merely altered propylite, or a decomposition product which differs from the original rock only in the addition of water and the removal of a small part of the alkalies. The difficulty, and perhaps impossibility, of obtaining rock which has not been altered in the Comstock region, makes it a delicate matter to institute comparisons between the clay and the original rock, but the following analyses given by Mr. Clarence King* will serve to show the change produced. The composition given for the clay is the mean of four analyses of clays taken from different points, and probably resulting from the alteration of two rocks, propylite and andesite. Analyses of both of these rocks are adjoined, but the specimens did not come from the same places, though they are from the same region. They were chosen out of a series because they are the only examples which are nearly free from the water. (See next column).

In order to obtain an analysis of nearly unaltered propylite it was necessary to take one which does not contain the usual proportion of alumina, while the alkalies are in corresponding excess over the proportion usual in the

* "United States Geological Expedition of the Fortieth Parallel," vol. iii., p. 89, and vol. i., p. 560 and 576.

	Clay.	Propylite.	Andesite.
Silica	56·24	64·62	58·33
Alumina	15·28	11·70	18·17
Oxide of iron	4·00	8·39	6·03
Lime	4·40	8·96	6·19
Magnesia	3·01	1·18	2·40
Soda	0·95	3·13	3·20
Potassa	3·24	1·95	3·02
Water	6·26	1·02	0·76
Carbonic acid	2·34	—	2·85
Phosphoric acid	0·08	—	—
Pyrite	4·36	—	—
	100·16	100·95	100·95

immediate Comstock grounds, so that the comparison is not entirely accurate. Still the analysis of the clay is the main thing, and the mean composition given shows what is invariably the fact in this locality, that the clay retains a large proportion of its iron, alkalies, and alkaline earths. It is impossible to say whether more or less than one-half of the soluble products have been leached out, and therefore it is incorrect to say that the solids present in the mine waters represent the kaolinisation of 12,703 tons of rock, as Mr. Phillips assumes. The true quantity of *leached* rock may be many times as great as this even in wet ground.

But the quantity of rock that yields solids to the mine waters by no means represents the quantity that is kaolinised. These waters do not permeate the whole mass of rock. On the contrary, nine-tenths of it is extremely dry, and the water is confined to narrow courses, which discharge an unceasing flood from a few points. The dry rock seems to be as hot as the rest, and, like the clay, its analysis exhibits the presence of water. One analysis made in a specimen that showed no signs of alteration, and was classed as a typical specimen of propylite, was found to contain 6·53 per cent of water, or more than the mean given above for the clay. The alteration was accomplished without affecting the physical appearance of the rock, and perhaps without lessening its constituents.

I have shown that this rock is permeated by currents of gas, which is frequently discharged from the drill-holes with force sufficient to move the flame of a candle. Probably this gas is partly composed of aqueous vapour, which is not perceptible to the eye in the hot levels of the mines, but is seen as a rushing column of steam forty feet high at the mouth of the shaft, where it encounters the atmospheric temperature. All the upcast shafts of the lode show this column of watery vapour, and it appeared to be just as strong in the Imperial, Bullion, and other mines, where fifty to one hundred men were employed, as in the California and Consolidated Virginia mines, each of which gave work to six or seven hundred men. The quantity of this steam in the upcast is much greater in the Comstock than in any other mines I have ever seen, though they are by no means the most heavily manned, nor the most watery excavations that have come under my observation.

It is extremely probable that even the dry rock is supplying heat by kaolinisation through the action of water vapour over large areas which never receive water enough to be robbed of their alkali by solution.

(To be continued.)

The Transformation of Amylen and Valerylen into Cymen and Benzenic Carbides.—G. Bouchardat.—The author has succeeded in converting the amylic alcohol of fermentation and the valerylen derived from it into benzenic carbides, and into cymen, $C_{20}H_{14}$, by means of successive subtractions of hydrogen, and into a second carbide, $C_{18}H_{12}$. He has also attempted the direct conversion of diamylen into cymen, seeking to withdraw 4 equivs. hydrogen by the successive action of bromine and potassa, but without success.—*Comptes Rendus.*

PROCEEDINGS OF SOCIETIES.

THE AMERICAN CHEMICAL SOCIETY.*

THE regular monthly meeting of the Society was held on Thursday evening, June 3, 1880, at University Building, Washington Square, New York. Dr. A. R. LEEDS, Vice-President, in the Chair.

Mr. Alexander Cochrane, of Boston, Mr. Hugh Cochrane, of Boston, and Mr. Lucius Pitkin, of New York, were elected Associate Members of the Society.

The following gentlemen were nominated:—

As Members:—Herman Poole, Buffalo, N.Y., Dr. Karl Stahl, Taeony Chemical Works, Philadelphia; G. T. Bihn, Philadelphia; and C. H. Torrey, School of Mines, N.Y.

As Associate Members:—Thomas Harrison, Philadelphia; and J. R. Savage, Philadelphia.

It was resolved that the Society should have a meeting, either formal or informal, in Boston, during the session of the American Association for the Advancement of Science; and that the First Vice-President should appoint five members of the Society as a Committe to carry out this resolution.

Mr. J. H. STEBBINS, Jr., S.B., read a paper on "*Some New Colouring Matters Produced by the Action of Diazo-compounds on Phenols.*" The first part of the paper was devoted to a history of the discovery and development of the diazo-compounds, beginning with the work of P. Griess in 1875 and running rapidly through a number of interesting and valuable researches down to the present time.

Mr. STEBBINS then went on to describe a number of new bodies which he had produced, and which are very interesting contributions to this wonderful series of chemical compounds. The first of these was azobenzol-trinitro-oxybenzol, made by the action of diazobenzol-nitrate on picric acid; it is explosive when heated. The next compound was azobenzol-pyrogallol, made by the action of diazobenzol-nitrate on pyrogallol; it crystallises in red-brown needles, slightly soluble in alcohol, and in this form is adapted for dyeing. Another body described was para-azosulphoxylbenzol-phloroglucine, made by acting on diazosulphanilic acid with phloroglucine. This body forms a soda-salt easily soluble in water, and also an acid-barium-salt less soluble in water than the soda-salt. Azobenzol-sulpho-cresol was the next body described. It is made by acting on cresol-sulpho-acid with diazobenzol nitrate; and crystallises in long red-brown needles with metallic lustre, soluble in alcohol and less so in hot water.

The above compounds had already been described by Mr. Stebbins in a previous paper to the Society; but he thought it best to review them and add some new facts. He now went on to describe the new dyes, the results of his recent researches.

The first of these new compounds is dinitro-oxy-azobenzol-ortho-oxysulphoxylbenzol, a compound intermediate between Griess's azosulphoxylbenzol-ortho-nitrophenol and Mr. Stebbins's azobenzol-trinitro-oxybenzol, and may be made from diazo-dinitrophenol and phenol-ortho-sulpho-acid. It crystallises in yellow-brown needles with metallic lustre, sparingly soluble in hot and cold water.

Another new body, made by Mr. Stebbins, is azonaphthalin-sulphoxyl-ortho-nitroxylbenzol, which is similar to Griess's azosulphoxylbenzol-orthonitrophenol. It is produced by treating diazonaphthionic-acid with orthonitrophenol. It forms red-brown microscopic needles, very soluble in water.

Up to the present time no attempts have been made to combine more than two sulpho-groups (HSO_3) in one compound. It occurred to Mr. Stebbins that possibly three such groups might be combined, and with this point in view the following body was produced:—

Para-azosulphoxylbenzol-beta-oxydisulphoxyl-naphthaline.—This body can be produced by several methods, but the simplest of these is by combining diazosulphanilic acid with naphtholdisulpho-acid. The free acid crystallises in pretty orange leaflets with beetle-green lustre, soluble in water with an orange colour. A lead salt of this compound was formed, giving a yellow powder soluble in water.

Azobenzol-disulphonaphthol was the next body described. It is made by treating the soda salt of beta-naphtholdisulpho-acid with diazobenzol-nitrate. This body forms both soda and barium salts, the former very soluble in water, and the latter only sparingly soluble in that liquid.

By combining diazo-toluol-nitrate and beta-naphtholdisulpho-acid, para-azo-toluol-beta-naphtho-disulpho-acid is formed. It is a fine scarlet dye. The free acid forms red-coloured leaves very soluble in water. The soda-salt is very soluble in water, and the barium salt is only sparingly soluble in that liquid. Mr. Stebbins stated that he had made the ortho and meta compounds of this last body in the same manner as the para compound just described, and that they resemble it more or less, giving only different shades of colour, one more yellow and the other more red. These last are also scarlet dyes soluble in water.

Parazo-sulphoxyl-naphthalin resorcin was produced by treating diazo-naphthionic acid with resorcin. The free acid of this body gives dark brown needles, very soluble in water.

The last body described was parazo-dibrom-sulphoxyl-benzol-beta-naphtha, obtained by allowing para-diazo-dibrom-benzol-sulpho-acid and beta-naphthol to act upon one another. The free acid is pretty soluble in hot water.

This highly interesting paper was illustrated by a number of samples of silk dyed with the new colours, whose richness and beauty of shade caused them to be much admired.

In the discussion which followed, Mr. Stebbins promised to finish up some of the details of the paper in the Fall, and remarked that many of the new colours were much faster than those of aniline.

Dr. A. R. LEEDS read a paper "*Upon the Action of Light and Darkness on Standard Tannin Solutions.*" In a previous paper the author had reviewed the labours of Schlœsing and Muntz upon the dependence of nitrification upon the presence of an organised ferment, and R. Warington upon the necessity of darkness to the development of the nitrifying body. The amount of ammonia converted into nitrous acid under the action of a fungoid growth in a standard solution of ammouium chloride placed in the dark for a considerable period, had also been given. In this communication the author stated that similar ammonium chloride solutions, from which, however, oxygen was excluded, did not change under the influence of a fungoid growth, in light or darkness, and with or without chloroform. Tannin solutions containing saproligneous growths, and to which the access of oxygen was permitted, changed little in diffused light, but to a great extent in darkness; the development of fungi being large, and the percentage of tannin diminishing during the lapse of eighteen months as much as 8 per cent. The presence of chloroform in the latter case retarded, though it did not prevent, the fungoid growth. The conclusions drawn from the experiments narrated were that the circumstances most favourable to the indefinite preservation of standard solutions of this character are exposure to light, exclusion of air, and the absence of germs of fungoid growth.

Dr. LEEDS also presented a memoir "*Upon certain New Methods in Actino-Chemistry. with their application to the Sun, Electric and Magnesium Light, and to the Actino-Chemical Analysis of the Atmosphere.*" The results obtained in three preceding communications, made to the Society in 1878 and the spring of 1879 were summarised, and the confirmation of the laws then announced which governs the rate of change of the soluble iodides in

* Communicated by Arthur H. Elliott, F.C.S., Recording Secretary.

the presence of actinic rays and of dilute acids was afforded by the results subsequently obtained by the use of chemically equivalent solutions of iodides and acids. The amount of iodine set free in the presence of hydrochloric acid in the sunlight was shown to be greater by a definite ratio than that liberated by sulphuric acid, whatever might be the nature of the iodide employed. The amount of decomposition effected by heat, the electric and magnesium light, was also given, and the relative amount of absorption of the actinic rays emitted from these sources, when passed through absorbing media.

NOTICES OF BOOKS.

Kelly's Directory of Chemists and Druggists. This work includes Chemical Manufacturers, Wholesale Druggists, Drysalters, Patent Medicine Vendors, and other Trades connected therewith, of England, Scotland, and Wales, and the principal Towns in Ireland. Fourth Edition. London, Kelly and Co.

In no department is a thoroughly accurate and complete directory more needed than in the chemical arts and manufactures. We therefore opened the present volume hoping that the want might at last be supplied, and that consumers of chemicals would no longer be put to trouble in finding where any given article was to be obtained. To decide on the value of such a work we must consider, firstly, the plan on which the authors have proceeded—what they have omitted and what they have included—and secondly, how this plan has been carried out.

In the first respect we cannot pronounce the compilation satisfactory. Turning to the index, we find no mention of manufacturers of bronze-powders, litharge, white-lead, ink, printers' ink, varnishes, gun-cotton, washing-powders. Soap makers are only to be found under the heading "Fancy Soap Manufacturers," where the enquirer is not likely to begin his search. Oil merchants and oil refiners are also absent. The manufacturers of and dealers in Prussian blue and ultramarine, if included, are not specially mentioned in the index.

On the other hand, valuable space is taken up by the insertion of herbalists, medical botanists, and of the hospitals and infirmaries. These items, indeed, together with the dentists, chiropodists, and veterinary surgeons, ought, we think, to be referred to a distinct medical directory.

Again, there figure here the makers of arrowroot, chocolate, cocoatina, dandelion-coffee, lozenges, extracts of meat, baking-powders, and gluten-bread. If such trades are admitted we see no just reason for not likewise including the manufacturers of sauces, pickles, jam, confectionery, tinned fruits, sardines, German yeast, &c. But the makers of all such substances ought to be classed along with the grocers, provision merchants, &c., and would be quite numerous enough to require a separate directory. We have grave doubts also concerning the photographers, whom we should be disposed to place along with artists, engravers, lithographers, &c.

It will be of course admitted that the more heterogeneous the contents of such a book the greater will be the difficulty of finding what is wanted.

The execution of the directory is much better than the plan. Under many places with which we are minutely acquainted we find the information given is quite correct. But even in this respect there are exceptions. Thus, at Aylesbury, we note the omission of a manure manufacture and of two manure merchants. We find the name of "Wanklyn, James A.," curiously placed among the chemists and druggists. Turning to the copperas manufacturers, we see that some of the most important are omitted, one in Droylsden, one in Leeds, and several in Wales.

The "bisulphite of lime" manufacturers figure here as makers of bisulphate of lime—a confusing error. Under "Tin Solution Manufacturers" we miss four firms o whose existence we are certain. Among analytical chemists now in practice we miss several, two of whom, we believe, are at present holding appointments as public analysts.

Enough has been said, we think, to show that the work requires a careful revision, and if the publishers could be induced to simplify its plan by the omission of trades and manufactures which cannot fairly be considered as chemical its utility would be much enhanced.

A Practical Treatise on Sea-sickness: its Symptoms, Nature, and Treatment. By G. M. Beard, M.D. New York: E. B. Treat.

In this little pamphlet the author combats successfully certain popular errors. He proves that sea-sickness is not a joke or a mere trifle; that instead of being ultimately beneficial it frequently entails prolonged or even permanent mischief, and sometimes proves fatal; that it is an affection, not primarily of the digestive organs, but of the nervous centres, and that it may be successfully combatted by means of alkaline bromides,—preferably the sodium salt—taken in full doses of from 30 to 90 grains. This treatment should be commenced two or three days before going on board, and continued till the danger is over. If this treatment is deferred till the attack has actually set in success is doubtful, as the remedy may then be rejected by the stomach before it can be absorbed into the system. Champagne, brandy, &c., the author pronounces useless. We hope his advice will be taken in this respect, since the atmosphere of a saloon where many of the passengers have unsuccessfully dosed themselves with brandy is truly distressing.

If Dr. Beard's treatment proves as successful as the cases described seem to warrant he may fairly take rank as a benefactor to the human race.

Manual for the Physiological Laboratory. By Vincent Harris, M.D., and D'Arcy Power. London: Baillière, Tindall, and Cox.

The tyro in physiological research is not bewildered with choice among a legion of manuals and handbooks, as is the chemical student. The authors, who have been for some years engaged in teaching practical physiology at the medical school of St. Bartholomew's Hospital, have found that the manuals of Foster and Langley, Schäfer, and Rutherford are too elaborate for the ordinary student, and do not contain any epitome of histology. Hence a deficiency exists, which they have endeavoured to supply by collecting and publishing the papers which have been yearly issued to their students, and which embrace an abstract of the histology and chemistry of the various organs, together with the methods of preparing tissues for microscopic examination. In our opinion, they have succeeded in producing a treatise which will be widely useful.

In the introduction we find directions for the preparation of tissues for microscopic examination—hardening, cutting, staining, and mounting.

In Part I. we come to practical histology. A list is first given of the apparatus and reagents necessary for the student, after which follows the consideration of blood, epithelium, endothelium, the connective tissues, cartilage, bone, muscular tissue, nerve tissue, the blood vessels, the alimentary canal and the glands connected with it, trachea and lung, skin and appendages, genito-urinary organs, the lymphatic system, the eye, the ear, the teeth, the nose, the mammary gland, and the ductless glands. In each case we find instructions for preparation, and an account of the structure of the part or organ.

The second portion of the book deals with physiological chemistry, and begins with a list of apparatus and experiments required, and with memoranda of experiments.

Under each substance are given the general properties and characteristic reactions.

An appendix gives an account of the injection of blood-vessels and lymphatics, the action of gases, chloroform, alkalies, alcohol, and electricity on the blood; the method of feeding the colourless corpuscules, the preparation of glycogen, leucine, biline, cholesterine; notes on the development of teeth; and a classification of staining fluids.

The chief objection we find to this book relates to its getting up. Out of a total of 124 pages, including the index, we find 15 entirely blank and 14 more than half-blank. We thought at first that this space had been purposely left for the introduction of notes by the student, but the position of the blank leaves bears no apparent reference to such a use. Surely useful and appropriate matter might have been found to fill up these "aching voids."

Science Lectures delivered in Manchester, 1879-1880. Eleventh Series. Manchester and London: John Heywood.

On opening this little book we were greeted by the unpleasant announcement that these lectures have been brought to a close owing to the want of interest on the part of the public. The attendance no longer justified the Committee in continuing the experiment which they had taken in hand. Everyone who glances over the list of subjects which have been treated of, and the names of the lecturers, must admit that Prof. Roscoe and his colleagues have done their part, and that Manchester has had a fair trial. The result, then, for the present at least, must be accepted as conclusive. It points, we fear, to the inference that the attendance at first was largely due to the novelty of the undertaking rather than to any widespread and abiding interest in science. We fear, consequently, that the similar courses of lectures which have been established in other large towns will have but a transient success.

In this final series three of the lectures, though of a most valuable and instructive character, scarcely come within the scope of the Chemical News. "Traps to Catch Sunbeams" is a curious title for the lecture on solar radiation, delivered by Capt. W. de W. Abney, F.R.S. The speaker began by pointing out the error conveyed in George Stephenson's dictum that coal is "bottled-up sunlight." He then explained the nature of radiant heat, which he said ought rather to be called radiant energy. He gave a description of the sun's surface, illustrated by one of Janssen's photographs, and entered upon the question of sun-spots and their cyclical recurrence, with their possible influences upon the seasons. In order to arrive at a complete knowledge of these sun-cycles he proposed the systematic measurement of solar radiation as a problem of national importance. He calculated the heat of the sun last year at 25000°, or more than twelve times the heat required to melt platinum. His account of the modifications of the solar spectrum due to atmospheric changes, and by which the approach of rain or of an easterly wind can be foretold, is exceedingly striking. In short, the character of the whole lecture can only serve to heighten our regret and surprise that it should be so little appreciated.

The Spirit of Nature: being a Series of Interpretative Essays on the History of Matter from the Atom to the Flower. By Henry Bellyse Baildon, B.A., Member of the Pharmaceutical Society, Author of "Morning Clouds," "Rosamond, a Tragic Drama," &c. London: J. and A. Churchill.

Mr. H. B. Baildon is a writer of multifarious pursuits and of attainments rarely combined by the same person. Like Apollo, he is devoted at once to poetry and to pharmacy. His acquaintance with chemistry and with botany is very much in excess of mere professional requirements. He is also a metaphysician, a theologian, and a classical scholar. We find in his book conceits quaint and even beautiful, as when he pronounces ferns to be "the Classics of Nature, owing their charm to symmetry, balance, refinement, restraint." The sense of beauty, whether it be a simple or a compound faculty, is evidently predominant in his mind, and gives a tinge to all he writes. Scarcely less prominent is another feature: although describing himself as "naturally apprehensive, sensitive, and timid," he is very far from undervaluing Mr. H. B. Baildon.

Turning now from the author to the book, we have to ask what do these "interpretative essays" really interpret? Upon what phenomena or what generalisations do they throw any new light? In the "prologue"—we cannot see why the ordinary and unobjectionable term "preface" is discarded—he declares that his purpose is an attack on materialism. To such warfare we can have no possible objection. But the question sometimes occurs to us whether "scientific materialism," or a materialistic tendency among scientific men, is really so common, prominent, and formidable as a certain school of writers and orators take for granted? We doubt whether the crusades preached against this same materialism may not have objects. We find in the work before us, published in this year 1880, a critique on the world-famed "Belfast Address" of Prof. Tyndall! The very words "promise and potency of all terrestrial life" are brought forward for a searching analysis. We should have thought that this Address, and these words in particular, had been already discussed *ad nauseam*, and that nothing both new and appropriate remained to be said upon the subject. Mr. Baildon seems to be of a different opinion, though whether he has succeeded in saying anything which had escaped previous writers is, to say the least, somewhat doubtful.

An important feature of the work before us is the contention that the law of Evolution, in its strictest sense, is not supported by the analogy drawn from chemical science. This analogy, he declares, "threatens continued hostility to the theory of Evolution so long as that theory maintains a unity of source for all life." His ground for this utterance is that the commonly received elements have not been resolved into one simple ultimate element. Of course it would be premature to declare that any one of these elements has yet been decomposed, and possibly their decomposition may lie beyond human resources. But is it legitimate to found an argument against Evolution upon what is possibly a mere temporary inability? We conceive that the analogy may be reversed: finding Evolution wherever we are able to see with sufficient distinctness, is it unfair to argue that the simple bodies of chemistry have also been evolved, perhaps from a few principles, perhaps from one primordial form of matter? Mr. Baildon, indeed, admits facts which, if furnishing no direct proof, are at least strongly in favour of the hypothesis in question.

The chief novelty in the work before us is a re-statement of the law of combination by weight, which the author proposes to express thus:—"That the weight of the atom of each element is a constant quantity, so that elements can only combine with each other in certain constant proportions or in multiples thereof." To this law is appended the corollary to the effect that:—"Compound bodies behave according to the same law as simple ones, their combining weights being the sum of the combining weights of their constituent elements." This simplification of laws of combination seems to us an improvement. Somewhat curious, however, is the accompanying definition of a chemical atom:—"That moiety of an element which is capable of combining with such moiety or more of any other element." The term "moiety" is here employed in a questionable manner. It is generally understood to signify a half share of anything in number, extent, or value. If we are to estimate a book in proportion to the novel facts or generalisations which it brings forward, or to the new light which it throws upon phenomena and laws already recognised, the "Spirit of Nature" cannot take a very high rank. The author's anti-materialistic

polemics, though well meant, savour of an *Ilias post Homerum*. The general impression produced upon our mind is that Mr. Baildon's centre of gravity—if we may use the expression—lies not in science but in poetry.

Pocket Mining Atlas, compiled from the latest Official Surveys and the most authentic sources. New York: Edwin Bolitho. (Engineering and Mining Journal.)

This atlas, as its name expresses, is composed of maps of the mining regions of the United States. Among these we may mention in particular the Dahlonega district, the copper and iron regions of Lake Superior, and the Deadwood, in Dakota, where the different mining properties seem to overlap each other, in some cases three deep. There are further maps of the Leadville district, in Colorado, the Central City and Silver Cliff regions, and of Caribon Hill in the same state. The Comstock, Eureka, Treasure Hill, and Tuscaroora districts in Nevada, and the Bodie in California make also a prominent figure. There are no indications of the geological character of the districts, which in maps of so small a size could perhaps scarcely have been introduced so as to be useful. Speculators in American mining properties will doubtless find this atlas valuable.

Special-Katalog der Königlich-Rheinisch Westfälischen Technischen Hoch-Schule zu Aachen. Aachen: Palm.

We have here a catalogue of the articles exhibited by the celebrated Polytechnic School of Aachen at the Dusseldorf Exhibition of Arts and Trades. Chemistry and physics do not appear to play a very prominent part in comparison with mechanics. We may notice a set of chemical preparations by Dr. A. Polis, and a model of sulphuric acid works for lecture purposes, constructed and presented by Dr. R. Hasenclever.

We find a general view of the School and of its new chemical laboratory, which are certainly most imposing structures. We must not, however, quote Waterton's—

> "The walls are thick, the servants thin;
> The gods without, the devil within,

since the internal appliances, in the shape of apparatus, specimens, models, and every other requisite, are on an even more liberal scale, and the numerous and thoroughly qualified staff of professors, assistants, and curators are a sufficient proof that the establishment is meant and fitted for sound earnest work.

CORRESPONDENCE.

IRISH BOG BUTTER.

To the Editor of the Chemical News.

Sir,—Mr. W. A. Carius, whose letter on "Irish Bog Butter" appeared in the Chemical News, vol. xli., p. 295, may be interested to know that, in the February number of the *Analyst*, there is a report of an interesting paper on this subject by Mr. G. W. Wigner, F.C.S., and Professor Church, M.A., F.C.S., read by the former gentleman at the meeting of the Society of Public Analysts held on January 5, 1880.

This paper contains the results of a careful chemical examination of two specimens of ancient butter, and if my memory does not deceive me, one of them presented evidences of having been enclosed in some kind of keg or tub. Reference was also made in the paper to the specimen of bog butter preserved in the Museum of the Royal Irish Academy.—I am, &c.,

Edwy Godwin Clayton.

TIN IN PRESERVED FRUITS.

To the Editor of the Chemical News.

Sir,—In reply to A. Percy Smith's query in the Chemical News, vol. xlii., p. 34, tin salts act as irritants, but as to the amount necessary to produce anything serious, I am not in a position to say.

It has long been known that tinned fruits, if kept for some length of time, get impregnated with the metal of the containing vessel.

Never having seen any published quantities of the metals so dissolved in the syrup, I give the following as being the highest in their respective kinds I have yet found, in the hope that others, who may have investigated the subject, may do the same.

Per 2 lbs. tin of Pine-apple—0·21 grain SnO_2, 0·39 grain Fe_2O_3.

Greengages—0·36 grain SnO_2, 7·22 grains Fe_2O_3.

Apples—0·34 grain SnO_2, 15·28 grains Fe_2O_3.

The two latter were same age, the exterior of the cans being weather-beaten. They were not edible, the metallic taste predominating so much; in the pine-apple the taste was perceptibly metallic.

The syrup in all the tins had visibly acted upon the containing vessel, not only at the level of the liquid, but all over the covered metal. On pouring out the contents, the surface was beautifully crystalline, similar to the *moiree metallique* produced by the action of HCl or H_2SO_4 upon tin. In no case did I detect lead.—I am, &c.,

George J. Wishart.

18, Picardy Place,
Edinburgh, July 20, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 26, June 28, 1880.

Researches on the Determination of the Wave-lengths of the Thermic Rays at Low Temperatures.—P. Desains and P. Curie.—The authors have endeavoured to solve this problem by the use of Fraunhöfer's net-work, employing a tissue of metallic wire of $\frac{1}{8}$ millimetre in diameter. Their results are given in the form of a table.

Evaporation-heat of Sulphuric Anhydride.—M. Berthelot.—The heat evolved by SO_3 solid being, according to the author's former determinations, +18·7, he concludes that the evaporation of sulphuric anhydride (SO_3 = 40 grms.) at about 18° absorbs −5·9; for S_2O_6, −11·8, a figure very near that of the heat absorbed by the evaporation of the same volume of solid water at 0° (−12·3).

On Certain General Relations between the Chemical Mass of the Elements, and the Formation-heat of their Compounds.—M. Berthelot.—The author asks what relations exist between the elementary chemical masses known as equivalents or atomic weights and the quantities or heat evolved, *i.e.*, the molecular work effected in chemical combination? If we examine the compounds formed in multiple proportions, we find that the heat evolved by the successive combinations of two elements, or of two bodies which are themselves compound, decreases gradually as one of the elements accumulates. As examples he takes the combinations of sulphur and of nitrogen with oxygen. The chief work is generally accomplished in the first act, which approximates the heterogeneous molecules. Hence, the systems formed are generally the less stable the greater is their complexity. The last compounds are

formed with extremely small disengagements of heat, in as far as these result from a purely chemical cause. When the components are not in the same physical state we obtain, in addition, the heat due to a change of such state, *e.g.*, the liquefaction of a gas or the solidification of a liquid, which is proportional to the number of elements fixed. Organic compounds of the same function evolve about the same quantity of heat when they experience a similar transformation. The close analogy which exists between the equivalents as well as between the majority of the properties of nickel and cobalt occurs also in the approximate identity of the formation-heats of their binary compounds. In the majority of elements a totally different relation prevails.

A New Form of Galvanometer.—L. Gastynski.—This galvanometer is intended for the measurement of thermo-electric currents, and is distinguished by the association of two astatic systems in the same direction. Its chief advantage lies in its proportionality, which may be extended to near 90°, and which dispenses with the construction of tables.

Existence in the Smoke of Tobacco of Hydrocyanic Acid, an Alkaloid as Poisonous as Nicotine and Various Aromatic Principles.—G. Le Bon and G. Noel.—The alkaloid in question has a pleasant odour but is dangerous to inhale, and has proved fatal to animals in doses of 1-20th of a drop. It appears identical with collidine, the existence of which has been traced in the products of the destructive distillation of several organic substances.

Vibrations on the Surface of Liquids.—F. Lechat.—The author, setting out from the general equations of the slight movements of liquids, establishes the mathematical theory of the vibrations on the surface.

Energetic and Constant Galvanic Battery yielding Residues Capable of being Regenerated by Electrolysis.—E. Reynier.—The zinc is immersed in a solution of caustic soda; the negative electrode, which is of copper, is depolarised by a solution of copper sulphate, separated from the alkaline liquid by a porous septum. A couple thus arranged is constant, and its electro-motive force is from 1·3 to 1·5 volt., according to the concentration of the liquids. The author diminishes the resistance of the soda and copper sulphate by the addition of salts suitably chosen. For the porous septum he takes several leaves of parchment-paper laid upon each other. No volatile products are formed.

Mechanical Effects Produced in the Magnetic Nucleus Submitted to the Magnetising Action of an Electric Current.—M. Ader.—The author's experiments show that all bars of a magnetic nature if submitted to pressure, torsion, or traction tend to resume their primitive molecular disposition under the influence of the magnetising current.

Independent Optical Compass for Ironclads.—M. de Fraysseix.—The author proposes to fix a compass at such a height that it is not affected by the iron work of the ship and to render it visible to the steersman by means of a special optical arrangement.

Thermic Study of the Alkaline Polysulphides.—P. Sabatier.—The successive equivalents of sulphur dissolve in dilute sodium sulphide, evolving +0·8 cal. per equiv. This value is the same for the tetra-sulphides of potassium and sodium.

Etherification of Hydriodic and Hydrochloric Acids.—A. Villiers.—Hydriodic acid behaves in a manner very similar to hydrobromic acid, but the etherification is effected much more rapidly. Hydrochloric acid is etherified much more slowly than the two other hydracids and than the organic acids.

Crystalline Anhydrous Lime.—A. Levallois and S. Meunier.—The crystals in question, which contain from 96·5 to 97·3 per cent of calcium oxide, have been obtained from the sides of a lime-kiln, which had been kept at a temperature of 1200° to 1300° for twenty-eight consecutive months.

Zeitschrift für Analytische Chemie.
No. 1, 1880.

Application of the Electric Current in Analytical Chemistry.—C. Luckow.—Inserted at length.

Method of Detecting and Determining Iodine in Presence of Chlorine and Bromine.—E. Donath.—Inserted at length.

The Solution of Arseniferous and Antimoniferous Compounds.—E. Donath.—Already inserted.

Behaviour of the Juices of Fruits of Different Ages with Reagents.—F. von Lepel.—An extensive memoir, not capable of useful abstraction and requiring the accompanying illustrations. It is of considerable value for the detection of sophisticated wines, fruit-syrups, &c.

Detection of Salicylic Acid in Wine and Fruit-Juices.—Dr. L. Weigert.—The well-known reaction with ferric chloride is not available in deeply-coloured liquids, especially if the proportion of salicylic acid does not exceed 2 to 3 per cent. The author shakes up 50 c.c. of the wine for some minutes in a flask with 5 c.c. of amylic alcohol, pours off the supernatant liquid into a test-glass, and mixes with it an equal volume of alcohol, in which the colourless amylic dissolves. To this mixture are added a few drops of the dilute solution of ferric chloride, which produces the usual well-known deep violet colour.

Composition of Various Foods for Children.—Dr. N. Gerber.—A tabular view of analytical results.

Supplement to Dietrich's Table for Calculating Nitrogen in Places where the Barometer is Low.—E. Trachsel.

Communications from the Laboratory of Prof. R. Fresenius at Wiesbaden. A New Method for Determining the Value of Zinc Powder.—V. Drewsen.—The author prepares two solutions; the one of pure fused potassic dichromate—say 40 grms. per 1000 c.c.—and the other of crystalline ferrous sulphate, about 200 grms. in 1000 c.c. The iron solution must be strongly acidulated with sulphuric acid, to prevent oxidation. In order to find the respective value of the two liquids, 10 c.c. of the iron solution are measured into a beaker, a little sulphuric acid is added, and the other solution is dropped in from a burette until a drop of the mixture is no longer turned blue by potassic ferricyanide. About 1 grm. of the zinc powder is then weighed, placed in a beaker with 100 c.c. of the chromic solution, 10 c.c. of dilute sulphuric acid are added, the whole is well stirred, 10 c.c. more of the sulphuric acid are added, and allowed to act for about a quarter of an hour with diligent stirring. When everything is dissolved except a small insoluble residue, an excess of sulphuric acid is added, and 50 c.c. of the iron solution in order to reduce the greater part of the excess of chromate; more of the iron solution is then added from a burette till a drop displays a distinct blue reaction with ferricyanide, and the mixture is then titrated back with chromate till this reaction disappears. From the total number of c.c. of the iron solution consumed the quantity is deducted which corresponds to the ferrous solution employed. The chromate contained in the remainder if multiplied by 0·66113, shows the metallic zinc contained in the powder.

The Determination of Sulphur in Sulphur Ores.—R. Fresenius.—An examination of Dr. G. Lunge's method as proposed in his "Manual of the Alkali Industry," i., 96.

Apparatus for Determining the Specific Gravity of Solid Bodies.—F. Frerichs.—This paper requires the accompanying illustration.

Chromometry.—G. A. Kœnig.—A modified application of the principle of the complementary colorimeter. Instead of dissolving an ore and examining the colour of the

solution, the author dissolves a small sample (5 m.gs.), carefully weighed in a bead of borax of known weight. He causes the melted bead to be drawn up into a fine platinum tube, and when cold, grinds off the projecting parts at both ends, so as always to obtain a stratum of equal length. He then looks through it, and through a glass wedge of a complementary colour, and observes what thickness of the wedge renders it colourless. By operating with specimens of known percentage a scale may thus be establised.

Steinle and Hartung's Graphite Thermometer and Pyrometer.—C. Winkler.—An illustrated paper.

Improvements in Orsat's Apparatus for the Analysis of Chimney Gases.—F. Fischer.—An illustrated paper. See *Dingler's Polyt. Journal*, ccxxvii, p. 257; and ccxxx., p. 480.

Assay of Platinum Alloys.—Nilson W. Perry.—From the New York *Engineering and Mining Journal*.

New Reaction for Salicylic Acid.—H. Schulz.—If a watery solution of salicylic acid, or better, of sodium salicylate, is mixed with a little solution of copper sulphate, the liquid, which was previously colourless, turns to an emerald green. The addition of a stronger acid destroys the green colouration.

Varrentrap and Will's Process for the Determination of Nitrogen.—In case of substances rich in nitrogen the addition of sugar is recommended by Prehn and Hornberger. Kreussler points out that in the analysis of proteic bodies, the results yielded by the Varrentrapp and Will process are generally too low, and those furnished by the Dumas process too high. He examines the sources of these errors at some length.

Determination of Zinc in Spring-waters.—E. Mylius. —In cases where iron is absent the author proposes the following colorimetric method:—2·60 grms. potassic ferrocyanide are made up to 100 c.c., and 3·536 grms. zinc sulphate to 1000 c.c., so that 1 c.c. of the latter solution contains 1 m.g. ZnO. Into a test-glass of about 4 c.m. in width there are poured 200 c.c. of the water to be examined, which should be clear and filtered. In another glass are placed 200 c.c. of spring-water free from zinc. To each is added an equal quantity, which may be from 5 to 8 drops of hydrochloric acid, and 2 c.c. of the solution of ferrocyanide. To the water free from zinc there is then added from a narrow burette, drop by drop, so much of the zinc solution as will render the turbidity equal to that in the water containing zinc. After this preliminary experiment a cylindrical glass is again charged with 200 c.c. of the water to be examined, 2 c.c. of the ferrocyanide solution and 8 drops of hydrochloric acid. Five other glasses are then charged each with 200 c.c. of water free from zinc, ferrocyanide and acid as before, and different quantities of the zinc solution. All the cylinders are then allowed to stand for half an hour, protected from too full daylight, and the turdidities produced are then examined. The author remarks that the parish well at Tuttendorf, which contains 0·007 gr. ZnO per litre, has been used for drinking for about a century without any perceptible injury.

The Ash in Wines.—H. Kayser.—In genuine wines, the ash bears to the extract the proportion of 1 : 10, with but little fluctuation. Other authorities make the range greater.

Method of Detecting Dyes used in Colouring Red Wines.—A. Gawalovski.—From the *Pharm. Central-Halle*.

Determination of the Extract of Wort and Beer.—V. Griessmayer.—Not capable of useful abstraction.

Analysis of Soaps.—Jul. Loewe.

Les Mondes, Revue Hebdomadaire des Sciences.
No. 1, May 27, 1880.

Contains no original chemical matter.

June 3, 1880.

This issue contains no chemical matter which has not appeared elsewhere.

June 10, 1880.

This issue is filled with extracts from various journals. Such of them as relate to chemistry and physics have been already noticed.

June 17, 1880.

Condensation of Gases on the Surface of Glass.—M. Chapuy.—From a surface of glass of 1·6752 square metre there were evolved, in the author's experiments, from 0°—180°, 0·45 c.c. hydrogen, 0·58 air, 1·03 sulphurous acid, and 1·410f ammonia.

Annales de la Société des Sciences Industrielles de Lyon
No. 1, 1880.

Galena Produced at the Lyon Glass Works.—F. Gonnard.—Well defined crystals of galena have been discovered at the bottom of a disused melting-pot.

Note on Certain Mineralogical Facts observed in the Granites on the Banks of the Saone.—F. Gonnard. —Among the minerals observed are orthose, pinite, pegmatite, garnets, almandine, black tourmaline, chlorophyllite (?), sericite (?), and rutile.

Reimann's Färber Zeitung,
No. 22, 1880.

The Fixation of Colouring Matters by Silica.—The author controverts the theory of G. Engel that the fixation of colours is due to capillarity. Experiment shows that precipitated silica attracts and fixes aniline colours, Turkey-red, &c., more strongly than siliceous infusorial earth, which alone of the two substances can be said to possess capillarity.

No. 23, 1880.

It is announced that Dr. O. N. Witt, the discoverer of chrysoidine, removes to Mulhouse in order to carry on certain investigations in the laboratory of Prof. Noelting.

The celebrated print works "Impressione Alsacienne" are in course of being dismantled and sold piece-meal.

No. 24, 1880.

Bleaching Tussah Silk.—It is asserted that the difficulty encountered in bleaching this silk is due to the circumstance that many parcels of it consist of two distinct kinds of fibre. One portion is readily bleached, and on microscopic examination displays the structure of silk. The other and larger portion is yellow, hard to bleach, and has a flax-like appearance.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.
No. 76, April, 1880.

This number contains no chemical matter.

THE JOURNAL OF SCIENCE
for July (Price 1s. 6d.), includes—

The Evolution of Scientific Knowledge. By C. Lloyd Morgan.
Habits and Anatomy of the Honey-bearing Ant.. By C. Morris.
The "Laws of Emphasis and Symmetry." By J. W. Slater.
Instinct and Mind. By S. Billing.
Tuberculosis transmissible through the Meat and Milk o Anima affected with it.
Natural Science and Morality. By S. Tolver Preston.
Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

Wanted, a Manager who thoroughly understands the making of Bisulphide of Carbon. A man with a little capital can have a share in the business. A first rate chance for a really good man.—Apply to Jos. Harris, 104, Corporation Street, Manchester.

Chemical Laboratory to be Sold.—Established 1848, by Dr. Sheridan Muspratt; successfully carried on till present time. The spacious laboratories and class-room are fitted with all modern conveniences.—Address, Principal, College of Chemistry, 96, Duke Street, Liverpool.

TO BE LET OR SOLD, on moderate terms, the whole or any portion of a Works situate near Wolverhampton, in a good state of repair, and having an area of about an acre. There is a branch from a main line of railway running into every part of the Works, and an extensive frontage to a Canal Wharf. The use of neighbouring boilers and engines may be had if required. Adjoins Oil of Vitriol and Manure Works, and unused Phosphorus and Copper Extracting (wet process) Works.—Address, Messrs. Slater and Marshall, Solicitors, Darlaston, near Wednesbury, Staffordshire.

TO OIL MERCHANTS, DRUGGISTS, and Others.—To be Disposed of by Private Treaty, the Old-established BUSINESS of Thomas Sneyd, of High Street, Walsall.

The Business has been established half a century, and, in addition to a Counter Trade, there is a good connection amongst the Manufacturers of the district.

For particulars apply to George Cotterell, Esq., Solicitor, Walsall; or Messrs. Lomas Harrison and Starkey, Accountants, 14, Temple Street, Birmingham.

Wanted, Quotations and Samples of Sulphide of Barium. FOR SALE, Sulphate and Carbonate of Barytes. All qualities, and specially made for Chemical and Colour purposes. —T. W. Ellis, Alphington Street, Exeter.

SOUTH LONDON SCHOOL OF PHARMACY.

Special advantages are offered to Private Students during the Vacation commencing the end of July, in every branch of Practical Chemistry, as applied to Manufactures, Agricultural and Commercial Products, Water, Gas, Food, &c.

For terms, personal or by letter, W. Baxter, Secretary, Central Public Laboratory, Kennington Cross, S.E.

C. H. GIMINGHAM'S PATENT COMBINATION BLOWPIPE,
FOR AMATEUR & PROFESSIONAL GLASS-BLOWING, &c
AS USED IN L. CASELLA'S WORKSHOPS.

The difficulties of Glass-Blowing are redueed to a minimum by this instrument. It combines the use of the large or small flame and large Bunsen flame, the changes from one to the other being made in less than one second.

SOLE MAKER—
L. CASELLA, 147, Holborn Bars, London, E.C.

SPECIALITIES.

Manganese.—Finest Crystallised, Lump, Ground, and Granulated of every quality, and Prepared for *Chlorine*, *Glass*, *Steel*, *Ferro-Manganese*, *Pottery*, *Battery*, and Every Purpose.

Bauxite.—(Hydrate of Alumina) Of high percentage of Alumina and almost free from Iron. The Cheapest, Best, and Most Profitable article from which to produce Alum, Alum Cake, and Sulphate of Alumina, &c.
[BRAND, "IRISH HILL BAUXITE."]

Fluor-Spar.—Of the Very Finest Quality for Acid, Soda, Glass Flux, and all purposes.

Barytes.—(Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

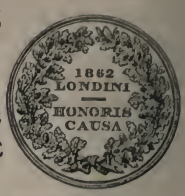
Cryolite.—Magnesite, Felspar, Arsenic, Phosphates, French Chalk, Strontia, Wolfram, Chromie, Terra-Alba, Rotten Stone, China Clay, Umbers, Ochres, Antimony, Calamine, Emery Stone, all Oxides, and all

Fuller's Earth.—Of superior quality, and entirely free from grit.
[BRAND, "EMERALD."]

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,
MINE PROPRIETOR,
Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.
OFFICES—26 CHAPEL STREET, LIVERPOOL.

BISULPHIDE OF CARBON
PROTOSULPHATE
RED OXIDE
OXYCHLORIDE
Sulphocyanide,



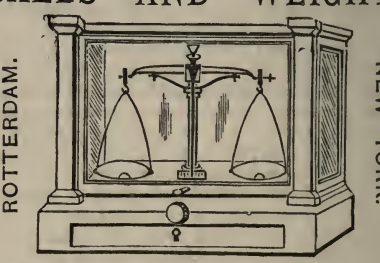
And every other Mercurial Preparation.

BISULPHITE OF LIME, TETRACHLORIDE OF CARBON.
Oxysulphuret of Antimony, Glacial Acetic Acid,

Liquor Ammoniæ,
Sulphide of Iron,
Pure Acids,
Chloride of Sulphur,
Acetone,
Chloroform,
Aldehyde,
Chlorate Baryta,
Arsenic Acids,
Fruit Essences for Confectionery & Liqueurs,
Perchloride of Iron,
Sulphite and Hyposulphite of Soda,
Phosphates of Soda and Ammonia,
Ethers,
Bromides,
Iodides,
Scale and Granular Preparations,
Sulphide of Sodium.

ALSO,
Pure Photographic Chemicals of every kind.
MANUFACTURED BY
WILLIAM BAILEY & SON,
HORSELEY FIELDS CHEMICAL WORKS,
WOLVERHAMPTON.

BECKER & SONS,
MANUFACTURERS OF
CHEMICAL AND GOLD ASSAY BALANCES
AND OTHER
SCALES AND WEIGHTS.



BECKER'S STUDENT'S BALANCE, in polished mahogany glass case, sliding front, counterpoised, to carry 30 grammes in each pan and turn to ½ milligramme, nickel plated pans £2 10
Ditto, ditto, in mahogany glass case, polished black.. .. .. £2 13

Sole Agents for England, Ireland, and Wales:—
TOWNSON & MERCER.

Becker's Complete Lists forwarded by post on receipt of 1*d.* stamp or free on application.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

THE CHEMICAL NEWS.

Vol. XLII. No. 1079.

NEGATIVE BONDS, AND RULE FOR BALANCING EQUATIONS.

By OTIS COE JOHNSON.

Prof. Hugo Schwanert, in his new "Lehrbuch der Pharmaceutischen Chemie," gives a rule for the construction of chemical equations. His method depends upon algebraical principles, as does also that of James Bottomley, read before the Manchester Philosophical Society, February 19, 1877, and given in the Chemical News, vol. xxxvii., p. 110.

My method is a chemical one, and is derived directly from principles of oxidation. It is founded upon a system of negative bonds. I here use the term bond in a sense partially new, which can better be understood by the illustrations that follow than by any definition which can be framed.

By the *bonds* of an element is meant the *amount of oxidation* it has sustained, or a *bond* is the *measuring unit of oxidation*.* The terms positive and negative are used *not* in an electrical but in a strictly numerical sense. The bonds of an element may always be ascertained with certainty by one of the following rules:—

(1.) Free elements have no bonds, and may be represented by zero, written thus—Cl° or Cl_2°, Ba°, Al°, &c.

(2.) Hydrogen in combination has always one bond, and it is positive, written thus, H^{I}.

(3.) Oxygen in combination has two bonds, always *minus*, written thus, O^{-II}.

(4.) The bonds of the metals in combination are usually *plus*. The most prominent exceptions are their combinations with hydrogen, $Sb^{-III}H^{+III}$, $As^{-III}H^{+III}$.

(5.) The sum of the bonds of any compound is always zero. Thus, $H^{I}N^{+V}O_3^{-VI=0}$; that is, the H has one positive bond, the N five positive bonds, and each atom of O has two negative bonds, and the three atoms have six negative bonds: six positive bonds added to six negative equals zero. In the same way, $H^{I}Cl^{+V}O^{-VI=0}$, $H_2^{II}S^{+VI}O_4^{-VIII=0}$, $H_3^{III}P^{+V}O_4^{-VIII=0}$,

$$Ba^{II}O_2^{-IV}H_2^{+II=0},\quad Fe_2^{VI}O_6^{-XII}H_6^{+VI=0},$$

$$Ba^{II}H_4^{+IV}P_2^{+X}O_8^{-XVI=0}.$$

(6.) Acid radicals are always negative, $H^{I}I^{+V}O_3^{-VI=0}$. or $H^{I}(IO_3)^{-I=0}$, $Pb_3^{VI}P_2^{+X}O_8^{-XVI=0}$,

or $Pb_3^{VI}(PO_4)^{-VI=0}$.

The bonds of the radicals being equal to the number of atoms of hydrogen with which it is capable of combining.

An *oxidising agent* is one that can increase the number of bonds of some other substance; hence oxidation of one substance *must* involve the reduction of some other. The number of bonds gained by one are lost by the other. The real bonds are transferred from the oxidising to the reducing agent. Thus in the equation—

$$2PbCrO_4+5Zn+16HCl=2Pb+Cr_2Cl_6+5ZnCl_2+8H_2O,$$

it can be proven that the ten bonds lost by the lead chromate are transferred to the zinc.

From these principles is derived a rule for writing equations, by which every equation involving oxidation may be balanced almost at a glance, if we know the products formed. The rule is:—*The number of bonds changed in one molecule of each shows how many molecules* of the other must be taken*, the words *each* and *other* referring respectively to *oxidising* and *reducing* agents. A few equations will illustrate:—

$$2HNO_3+3H_2SO_3=3H_2SO_4+2NO+H_2O.$$

The nitrogen in HNO_3 has five bonds, and in NO it has two, losing three, therefore three molecules of H_2SO_3 must be taken. The sulphur in H_2SO_3 has four bonds, and in H_2SO_4 it has six, gaining two, therefore two molecules of HNO_3 must be taken. Again,—

$$3Sn+4HNO_3=3SnO_2+4NO+2H_2O.$$

The Sn gains four bonds (free elements having no bonds), hence four molecules of HNO_3 must be taken, and the N of HNO_3 losing three bonds, three of Sn must be taken.

$$6Sb+10HNO_3=3Sb_2O_5+10NO+10H_2O.$$

Here the rule calls for three of Sb and five of HNO_3, but since the product Sb_2O_5 cannot be written with an odd number of atoms of antimony, we must double the amount of each, and instead of three and five take six and ten.

$$3H_2S+HNO_3=3H_2SO_4+8NO+4H_2O.$$

Here the sulphur in H_2S has -2 (*minus* two) bonds, and in H_2SO_4 it has $+6$, so it has gained eight bonds; hence we must take eight molecules of HNO_3, and we take three of H_2S, because the nitrogen loses three bonds.

$$3Sb_2S_3+28HNO_3=3Sb_2O_5+9H_2SO_4+28NO+5H_2O.$$

In this equation both the sulphur and the antimony of Sb_2O_5 are oxidised; each atom of sulphur gains eight bonds (as explained above), and the three atoms will gain twenty-four bonds. Each atom of the antimony gains two bonds, the two atoms gaining four bonds. These added to the twenty-four bonds gained by the sulphur, make twenty-eight (that is, one molecule of Sb_2S_3 gains twenty-eight bonds); hence we must take twenty-eight molecules of HNO_3, also three of Sb_2S_3, because the nitrogen of the HNO_3 loses three bonds.

$$HIO_3+3H_2SO_3=3H_2SO_4+HI.$$

In this the rule calls for two HIO_3 and six of H_2SO_3, but we take one and three, which are in the same proportion. The rule gives relative quantities only.

$$3Pb+2+6HNO_3=3Pb(NO_3)_2+NO+4H_2O.$$

Here the rule requires two of HNO_3, and shows that exactly two are reduced to NO; but in order to make a solution of lead nitrate six more must be added, which are not reduced.

$$3NaH_2PO_2+7HNO_3=3NaNO_3+3H_3PO_4+4NO+2H_2O$$

Here the phosphorus gains four bonds, and four of HNO_3 are reduced to NO; but three more are required to liberate the hypo-phosphorus acid from $3NaH_2PO_2$, hence we take seven in all.

$$AsH_3+6AgNO_3+3H_2O=6Ag+H_3AsO_3+6HNO_3.$$

The arsenic in AsH_3 has *minus* three (-3) bonds, and in H_3AsO_3 it has *plus* three ($+3$); the gain is six, therefore take six of $AgNO_3$.

$$3KNO_3+8Al+5KOH+2H_2O=3NH_3+4K_2Al_2O_4.$$

The nitrogen in NH_3 has -3 bonds, having lost eight, therefore take eight of Al; and as the Al gains three, take three molecules of KNO_3.

This article will be followed by another showing the use of the rule in organic chemistry.

University of Michigan,
July 7, 1880.

* As this definition of *bond* is a new and provisional one, possibly the adoption of a *new term* might be less objectionable than the use of new definitions for the established term, bond, as a character in quantivalence.

* In case of free elements, to avoid complexity, atoms are represented as molecules.

Carbazol.—C. Graebe.—The author describes the preparation of carbazol and potassium carbazol, and gives an account of the derivatives methyl-carbazol, ethyl-carbazol, ethyl-carbazoline, acetyl-carbazoline, tetra-nitro-carbazol, and the chlorine derivatives.—*Liebig's Annalen*, 202, 2.

THE HEAT OF THE COMSTOCK LODE.*

By JOHN A. CHURCH, E.M., Ph.D., New York City.

(Concluded from page 43.)

I HAVE explained in a previous paper, and also in a subsequent publication,† that the movement of gaseous currents in the solid rock has the effect of bringing each part of the mass under the influence of all the heat produced in the rock below it, for the gas is one of the results of kaolinsation. It is released at the moment of alteration, and has no alternative but to take its way to the surface, carrying with it part of the heat produced, which it distributes through the whole mass of rock.

It is probably owing to the operation of this gaseous current that the immense quantity of heat observed is discharged into the mine levels, and the water may receive part of its heat in the same way. A water-course and a mining gallery are both localised things placed in fixed positions in the pathway of a hot gaseous current, and the heat they receive may be (and in the case of a gallery with the air in it certainly is) derived in part from alteration proceeding in the rock at considerable distances from them.

For this reason the conception of Mr. Phillips, that the rock "would require to be heated by the kaolinisation of its felspar to a temperature above that of molten gold," has no foundation either in the theory or facts presented by me. The problem laid before us in the mines of the Comstock is as complex as it is interesting. I am justified in saying of all other theories that they do not even attempt to explain the facts. The explanation I give is still merely a hypothesis, but at the present day it is unique in being based upon a careful statement of the observed phenomena.

Another of my critics is Prof. G. F. Barker, of the University of Pennsylvania, who is reported to have said that the rock of the Comstock is not uniformly heated to 130° F., the remark being made to Dr. J. P. Lesley, and apparently as a contradiction of a statement made in my paper. Prof. Barker's remark, as quoted by Dr. Lesley, was "that there was no uniform temperature; but, on the contrary, the most remarkable differences, some of the higher levels being much hotter than some of the lower levels." This state of things was fully stated by me; and I showed that, while the great mas of rock near the two-thousand level, had a "pretty uniform temperature of 130° F.," it also contained narrow belts, most of which are hotter, while some are colder than the general mass. In any given mine the drift on a high level may be run for a long distance in a hot belt, and be much hotter than a drift two hundred feet lower, if the latter is carried through what I have called the general mass of rock. I regarded the extreme local temperatures as significant phenomena, the explanation of which would carry with it the whole theory of heat production, and discussed them to that end.

Professor Barker's opinion is, that the heat is a hot-water heat, and that the water is heated by the movement of the rocks. It is true that incessant and great movement of portions of the rock is encountered in the mines; but the opinion in question does not take into consideration the character of this movement. Every miner on the lode will sustain me in saying that the motion consists in the swelling of parts of the rock when its conditions have been artificially altered by the excavations of the mines. The usual explanation is, that this swelling is caused by the admission of air and moisture brought in by the artificial openings, an impression in which I fully concur. There are no indications that this movement takes place at a distance from the drifts, and there is no sign of natural movement at the depth of two thousand feet sufficient to produce as much heat in a year as the complete combustion of 28,601 tons of carbon, this being a low estimate of the quantity of heat withdrawn in the mine waters and air.

In this connection there is great significance in the fact that the first thousand feet of depth does not exhibit unusual increase of temperature, though this is especially the zone of oxidation, solution, and consequently of movement resulting from changes of volume.

I am indebted to Mr. Charles Forman, of Virginia City, Nevada, for valuable facts upon this subject. He is superintending the sinking of a shaft which is designed to reach the lode at a depth of about four thousand five hundred feet, and, with enlightened regard for exact knowledge on this interesting subject, he procured for use in the shaft a Negretti and Zambra slow-action thermometer, of the pattern adopted by the Underground Temperature Committee of the British Association, and standardised at Kew. The shaft is now one thousand feet deep, and I have received from him the following data obtained by the use of this instrument:—

"Temperature of the ground in Forman shaft, from the surface to the depth of one thousand feet, as ascertained by drilling holes three feet deep into the rock and inserting a Negretti and Zambra mining thermometer in the hole; closing the hole with clay, and leaving the thermometer for twelve hours; not less than three holes being tried at each point:—

Depth.	Temp.	Increment.	Decrement.
100 feet	50½° F.		
200 ,, ...	55	4½°	
300 ,, ...	62	7	
400 ,, ...	60		2°
500 ,, ...	68	8	
600 ,, ...	71½	3½	
700 ,, ...	74¾	3¼	
800 ,, ...	76½	1¾	
900 ,, ...	78	1½	
1000 ,, ...	81½	3½	

The increase of temperature is 31¼° in nine hundred feet, or precisely 3½° in one hundred feet. This determination has especial value, because the shaft is nearly a mile and a half east of the lode, and therefore not controlled by its physical conditions. The shaft has been quite wet, and its temperature may have been affected by the presence of water. This series of observations promises to be extremely valuable.

I have discussed this subject at length because of the interest which has been shown in it and because of its intrinsic importance. The Comstock Lode is unique as *the* hot lode of the world. I have followed up several reports of hot veins elswhere and have learned that whilst "hot springs" are known in other mines, there is no other metalliferous deposits of which I can hear that presents the peculiarity of this locality and which may be stated as *hot rock*, comprising the whole country of the lode. The Mexican mines are hot on account of bad ventilation, but I have ascertained that the rock is not hot. The quicksilver and sulphur deposits of California have shown great heat in a superficial stratum, but I am informed that the heat dissappeared at the depth of a few feet. Another mine near the Comstock was reported to be hot, but this turned out to be heated by a steam-pipe which the geological observer had not noticed. At Steamboat Springs, seven miles north-west of the Comstock, there is a mass of quartz which has been mined for a small proportion of mercury which it contains. This is really another hot locality, and its heat is the more remarkable because the mass is almost pure quartz. Half a mile away are the springs which steadily pour out a current of boiling water, from which silica, with occasional traces of sulphur, cinnabar, and even gold, are said to be deposited. Probably the heat of the quartz body is intimately connected with the source from which the springs derive their heat, and the whole locality is in the Comstock neighbourhood.

* A Paper read before the American Institute of Mining Engineers at the New York Meeting, February, 1880.

† "The Comstock Lode, its Formation and History," published by Wiley and Sons, New York, 1879.

Mr. R. Pearce, of Argo, Colorado, has kindly called my attention to the analysis of a hot spring in a Cornish mine, which he investigated several years ago. The analysis was made by the late W. A. Miller, M.D., Treasurer of the Royal Society and Professor of Chemistry in King's College, London. It was published in the CHEMICAL NEWS, vol. x., p. 181, and is given below. It presents two remarkable peculiarities, showing in one gallon no less than 216·17 grains of calcic chloride, and 26·05 grains of lithic chloride. The water is described as forming "a spring" in the mine.

Analysis of Cornish Mine Water.

From a hot spring in Wheal Clifford Mine, Cornwall: Depth, 1320 feet below the mean level of the sea. Flow, 150 gallons per minute. Temperature of water 125° F. Sample collected by Mr. R. Pearce. Analysis by Prof. W. A. Miller, F.R.S.

Specific gravity at 60° F.	1·007	
Gases—		
1 imp. gallon, at 30 in. bar. and 60° F., contains	8·91	cub. ins.
Consisting of—		
Carbonic acid	1·89	,,
Ratio of O to N, 1:3 { Oxygen ..	1·72	,,
Ratio of O to N, 1:3 { Nitrogen ..	5·30	,,
Solids—		
1 imp. gallon contains fixed salts, by evaporation	646·10	grains.
Consisting of—		
Chloride of lithium	26·05	,,
Chloride of potassium, with a little chloride of cæsium	14·84	,,
Chloride of sodium	363·61	,,
Chloride of magnesium	8·86	,,
Chloride of calcium	216·17	,,
Sulphate of calcium	12·27	,,
Silica	3·65	,,
Oxides of iron, manganese, and alumina	traces	
	645·45	

ON THE ANALYSIS OF SOAPS.

By JUL. LOEWE.

For the determination of moisture the author takes from 8 to 10 grms. shaved very finely, and dries them, first, at 60° to 70°; afterwards, at 100° to 105°. If it is supposed that the soap contains caustic alkali, the process must be conducted in an atmosphere free from carbonic acid. The free alkali may also be determined before the process of drying by exposing a portion of soap, shaved very fine and weighed, upon a watch-glass in a cylinder filled with dry carbonic acid and closed, the proportion of caustic alkali being calculated from the increase of weight. The exposure must not last too long, in order to prevent the formation of bicarbonate.

To determine free unsaponified fat, the portion of dried soap is thrown into a rather high beaker capable of being well covered, and extracted with benzol or petroleum with the aid of heat, according to the method of Perutz, and decanting when clear into a small tared flask. If the decantation is difficult it is passed through a weighed filter, which is afterwards used for the alcoholic solution of the soap. After two or three extractions the filtrates are collected and distilled, the residue dried at 108° in a chloride of sodium bath, and the increase of weight of the flask is noted, which shows the proportion of the non-saponified fat.

The residue freed from such fat is covered with about 8 to 10 parts of alcohol at 90° per cent, and heated to 40° to 50° in the water-bath. Caustic alkali, and that in combination with fatty acids, along with glycerin, are readily dissolved, whilst soda (carbonate), farina, and mineral impurities remain undissolved, and after washing with hot alcohol and drying at 100° may be weighed. In the better class of soaps the residue does not exceed 1 to 1½ per cent.

A moderate stream of well washed carbonic acid is then allowed to play upon the surface of the warm alcoholic filtrate. Caustic alkali, if present, is deposited as alkaline carbonate. The beaker is covered, allowed to stand till clear, heated in the water-bath, the contents filtered, and the filter is washed with warm alcohol. In the aqueous solution of the residue the carbonate of soda may be determined volumetrically.

The second alcoholic filtrate, thus freed from soda, is mixed with sulphuric acid diluted with alcohol as long as a turbidity is produced. When clear the sulphate of soda deposited is filtered off, collected upon a weighed filter, washed with alcohol, dried at 110°, and weighed. The weight shows the alkali which was in combination with the fatty acids.

The filtrate is acidulated with sulphuric acid, mixed with water, and freed from alcohol by evaporation in a platinum capsule. When cold, the acid aqueous extract which may contain glycerin, is separated from the congealed fatty acids by filtration. These acids, as well as the glycerin, may be determined by known processes, the latter after the accompanying sulphuric acid has been saturated with barium carbonate.

The residue, insoluble in alcohol after being weighed, is washed with cold water till the filtrate makes up exactly 60 c.c. The water is then driven out of the filter by means of alcohol, and the residue is dried at 100°.

After being weighed the residue is submitted to microscopic examination in order to detect starch. Mineral impurities are sought for by ordinary analytical methods. —*Zeitschrift für Analytische Chemie.*

REVIEW OF BERTHELOT'S "MÉCANIQUE CHIMIQUE."* †

By CH. DE MARIGNAC.‡

On witnessing the calorific effects which accompany the act of chemical combination, chemists have at all times sought to determine the relations which exist between these two classes of facts; on the one side, affinity, considered as the cause of all chemical combination; and, on the other side, the heat produced when this combination takes place.

A century ago, Lavoisier explained this relation by assuming that simple bodies are only known to us in a state of union with a certain quantity of caloric, which is set at liberty when these bodies enter into chemical combinations. Having his attention more exclusively attracted to the phenomena of combustion, he attributed this too exclusively to oxygen. Later, it was admitted for all the elements.

The brilliant discoveries of Davy, on the chemical decompositions effected by the galvanic current, gave rise to the electro-chemical theory, proposed by this scientist, and afterwards adopted and modified by Ampère and Berzelius, which caused heat and affinity to be looked upon in an entirely new light. According to this theory, affinity is merely the reciprocal attraction of the opposite electricities, which exist in either a free or a polarised state in the elements which tend to combine, and the heat

* Communicated to the CHEMICAL NEWS by the translator, P. Casamajor.

† "Essai de Mécanique Chimique, Fondée sur la Thermo-chemie," par M. Berthelot; Dunod, Editeur, Paris, 1879.

‡ Published in the *Archives des Sciences Physiques et Naturelles*, and re-published in the *Moniteur Scientifique*, of February, 1880.

observed in chemical combinations results from the mutual neutralisation of these electricities.

When chemists abandoned the electro-chemical theory, they returned to the system previously adopted, admitting, at the same time, the pre-existence of caloric in all the elements. But, about this time, an important revolution took place in the physical sciences; heat and electricity ceased to be considered as material fluids, combined more or less intimately with ponderable bodies, and came to be regarded as modes of motion. The discoveries of Mayer, of Golding, of Joule, had demonstrated the mechanical equivalent of heat. This new doctrine necessarily modified the ideas entertained by chemists concerning the origin of the heat and the electricity evolved in chemical reactions, and led them to consider these manifestations as complementary to one another, and as resulting from the loss of molecular impetus attending the act of combination.

Vast erudition, and long bibliographical researches, would be necessary, to follow this change of doctrine, and to apportion to each scientist the share which he had in it. We may, however, cite the memoir of M. Henri Sainte-Claire Deville (1860), and those of Babinet (1866).

A Danish chemist, Mr. Thomsen, whose labours have greatly contributed to the progress of thermo-chemistry, published in 1853 a series of memoirs,* in which he explained the principles of this new science. Without deriving them explicitly from the mechanical theory of heat, he expresses the basis on which they rest in terms which recall this theory. He founds them on the two following principles:—

1. The intensity of chemical energy in a given body is constant when the temperature is invariable.

2. The totality of the heat given out in a chemical reaction is the measure of the chemical energy brought to bear in this reaction.

The chemical energy of a body, or, what is identical, its capacity of developing heat, is what Mr. Thomsen calls its *thermo-dynamic equivalent*.

Mr. Thomsen has since tried to show that all the laws of thermo-chemistry subsequently established by M. Berthelot were derived from the second of these principles. It is true that they may be considered as consequences of it, but only by including conditions and restrictions which are not found in the statement of this principle. The best proof of this is that fifteen years later,† when Mr. Thomsen attempted to establish an agreement between his principles and the manner in which bases and acids are divided in a mixture of salts, he had to introduce a new force, *avidity*, which is an inherent property of these bodies, and in which it is difficult to find anything different from chemical affinity under another form, independent of that which is measured by the heat given out in combinations.

It is in reality to M. Berthelot that the honour belongs, of having stated with perfect precision the fundamental principles of thermo-chemistry, and, above all, of having shown, by a prolonged and numerous series of experiments, that these principles are sufficient to account for all chemical reactions.

Gifted with an eminently philosophical spirit; deeply versed in mathematics and in the physical sciences; trained to the most extended researches by his labours on chemical synthesis, this scientist was better able than any one else to accomplish the task to which he has devoted himself, which is to show the application of the principles of mechanics to the formation of organic compounds, and even to chemical reactions generally.

From this, it was not sufficient merely to determine the heat given out in chemical reactions. A not less important portion of the labours of M. Berthelot has been the study of the conditions under which such reactions take place, and more especially the study of the chemical equilibrium which results from two contrary reactions, which are reciprocally limited. This happens in the formation of ethers, in decompositions and inverse re-combinations produced by electricity, &c.

Through the study of these subjects, the author was led to new and important results in a branch of chemical mechanics, already successfully cultivated at the beginning of this century by Berthollet, under the name of *chemical statics*. He has shown that the theory of Berthollet, by which we are enabled to foretell chemical phenomena from the mere knowledge of the physical conditions of insolubility and volatility, has no foundation, except when there already exists a previous equilibrium, which constantly tends to renew itself. But the permanency of this equilibrium, and even its existence, are dependent on a still more general condition, which had never before been pointed out, and which has been defined in the principle of *maximum work* laid down by M. Berthelot.

These researches have taken sixteen years—since 1864. The results have been given in numerous memoirs, published in the *Annales de Chimie et de Physique*. M. Berthelot acknowledges the great help he has had from the labours of his predecessors, Hess, Graham, Andrews, Favre, and Silbermann, and in numerous series of numerical determinations of the quantities of heat given out in combinations, made by Mr. Thomsen, which are generally remarkable for their accuracy.

This subject is not exhausted, and will not be for many years, but M. Berthelot thinks that the time has come for him to state the laws and general principles, the search of which has led him to this long series of experiments, and to show in what manner the ideas recently acquired on the theory of heat, allow us to bring the whole of chemistry, that is, the formation and reactions of organic as well as of mineral substances, under the same principles of mechanics which govern other branches of physics; whence the title of "Essay on Chemical Mechanics founded on Thermo-chemistry," given by the author to the work which we are reviewing.

In his introduction, M. Berthelot states the three fundamental principles of thermo-chemistry and chemical mechanics, viz.:—

1. *Principle of Molecular Action.*—The quantity of heat given out in any reaction is the measure of the sum of the physical and chemical work accomplished in this reaction.

This principle gives the measure of chemical affinities.

2. *Principle of the Calorific Equivalence of Chemical Transformations, or, in other words, Principle of the Initial and Final State.*—If a system of simple or compound bodies, taken in determinate conditions, suffers physical or chemical changes capable of bringing it to a new state, without giving rise to a mechanical effect exterior to the system, the quantity of heat given out or absorbed by the effect of these changes, depends solely on the initial and final states of the system; it is always the same, independently of the nature and sequence of intermediate states.

3. *Principle of Maximum Work.*—Every chemical change, accomplished without the intervention of a foreign energy, tends toward the production of the body, or system of bodies, which gives out the greatest quantity of heat.

The prevision of chemical phenomena is, by this last principle, brought down to the purely physical and mechanical idea of the maximum labour accomplished by molecular action.

The following principle, deduced from the preceding, is applicable to a multitude of phenomena:—

> Every chemical reaction, which may be accomplished without the help of a preliminary action, and apart from the intervention of any energy foreign to the bodies present in the system, will necessarily take place if it be attended with evolution of heat.

The first two principles above given had not heretofore been stated in such precise terms, but it may be said that they had been implicitly admitted by the previous investigators in thermo-chemistry. It was, however, M. Ber-

* *Pogg. Ann.*, lxxxviii., 349; xc., 261.
† *Pogg. Ann.*, cxxxvi., 65; also *Archives*, 1869, xxxvi., 301.

thelot, who first called attention to the principle of maximum work, which is the basis of chemical statics.

In the statements made above, we may note the particular care taken by the author in distinguishing, in the calculations of reactions, the heat given out by chemical reactions, properly so-called, from that due to change of state, and which is derived more specially from physical energies, such as the liquefaction of gases, the solidification of liquids, changes of volume and of specific heats of gases, of liquids, and solids; changes of tension in vapours, and of fluidity in liquids, of crystallisation and of crystalline form in solids; also various modifications of the amorphous state.

It is, indeed, only on the condition of keeping account of all these circumstances, and of eliminating the share of all these physical causes, that we are able to ascertain that the heat given out in a reaction, is the exact measure of the affinities brought into play.

The first volume of M. Berthelot is specially dedicated to *chemical calorimetry*, which is the study of the quantities of heat given out in chemical reactions. It forms the exposition and confirmation of the first two principles stated above.

These principles cannot be demonstrated *à priori*. They are founded on a hypothesis, in itself very probable, that the imperceptible molecular motions developed in chemical reactions, obey the same laws as the motions of mechanical motors, which may be seen and measured. The accuracy of this hypothesis can only be established by long series of experiments, and by the constant conformity of the results obtained with those foreseen by theory.

The first volume is divided into three books. The first book develops the rules and general methods of chemical calorimetry. The author reviews the various reactions, combinations of elements, formation of salts, &c. He gives the calculations for each case, also gives rules for taking into account all the physical actions which intervene in these reactions, and shows by numerous examples the agreement of experience with the fundamental principles established by him.

One chapter is devoted to the quantities of heat which come into play in the reactions which take place in living beings. Another chapter treats of the variation of the heat of combination as influenced by temperature.

The second book contains descriptions of experimental processes and of calorimetric apparatus, for the determination of the quantities of heat given out in chemical reactions, of specific heats, and of the heat due to changes of state.

The great experience of the author gives a special interest to this description of the methods and apparatus used by him, in which he has succeeded in uniting simplicity with accuracy, and in which he has tried to eliminate or, at least, to reduce as much as possible, the corrections made necessary by the influence of exterior causes.

The third book is devoted to numerical tables. It includes numbers obtained by experiment, representing the quantities of heat given out or absorbed during physical or chemical changes of state which these bodies undergo in the operations of our laboratories. It therefore contains, besides results of thermo-chemical experiments, all the data relating to specific heats, and to changes of state (latent heats). It forms an extensive and exceedingly useful compendium of the labours of all the scientists who have studied these questions. We also find in this portion very interesting discussions on numerous theoretical questions suggested by the examination of these results. We may cite more specially those which relate to specific heat.

M. Berthelot states that the specific heat is the only physical property by which simple gases differ from compound gases. This property, however, is sufficient to establish between these two groups such an important difference, that it is impossible to suppose that any of the gases now considered as simple, results from the union of several other elements, such as we admit them at the present time, or from the condensation of several equivalents of the same element. This union or condensation must be understood to be comparable to that which gives rise to compound bodies, such as are now known to us. Simple gases differ from all compound gases formed with condensation, by the constancy of their specific heat, while for these last the specific heat increases rapidly with the temperature, and always exceeds in a notable manner, at all temperatures, that of simple gases. They also differ from compound gases, formed without condensation of their elements, such as hydrochloric acid and carbonic oxide (corresponding to four volumes, according to the system of notation of the author), whose moleular specific heat is equal to that of simple gases, and also remains constant at all temperatures, by the fact that the molecular volume always corresponds to one equivalent for these compound gases, while it represents two or four equivalents for all the known elements.*

In the chapter relating to specific heats of solid bodies, occur very interesting observations on the law of Dulong and Petit,† and on the relations which exist between the specific heats of compound bodies and those of their elements.

The second volume of the work of M. Berthelot, is specially dedicated to establishing the bases of chemical mechanics.

The object at which the author aims is the highest that science can propose to itself. Instead of confining itself to the individual description of the properties, the preparation and transformations of chemical species, science must endeavour to discover the laws governing these transformations; the causes and proximate conditions which determine them. The complete solution of this problem of chemical mechanics is not yet possible, and will not be possible for many years. To solve it, we should know, in every reaction, the masses of the particles brought into play, their relative positions, the proper motions of each particle, the exact nature, and the laws which govern the forces which react on each other. Most of these data are wanting, and even if they were known, it is doubtful if any method of calculation would allow us to solve such a complicated problem.

However, some portions of the problem may be attempted. For a long time, all that relates to the proportions in which combinations take place is known by the laws of definite proportions, of multiple proportions, and of equivalents. As to the prevision of reactions, we have only had the laws laid down by Berthollet at the beginning of this century. These only apply to special cases, and meet with frequent exceptions. M. Berthelot replaces them by a more general law, by which the prevision of the reciprocal actions between simple and compound bodies is reduced to the determination of the thermic properties of the reacting bodies. We may, by this new law, foresee the reciprocal actions of compounds towards one another and towards simple bodies, when we know the quantities of heat given out in the formation of

* This difference is not so much in the specific heats themselves as in the relations of molecular volumes to equivalents. In this respect the reasoning of M. Berthelot does not seem to me unobjectionable. It would be so if the determinations of equivalents rested on fixed rules. But, as he himself acknowledges (Introduction, page 21), "equivalents are only determined within an approximation of a multiple," it would only be necessary to change the multiple which has been chosen more or less arbitrarily, for a given body, to change the relation between its molecular weight and its equivalent, which the author regards as characteristic of simple and compound gases. As an instance, it is not clear why M. Berthelot considers the molecule of carbonic oxide, C_2O_2 (four volumes), as representing one equivalent. In the combinations of this gas with oxygen, chlorine, and sulphur, it would appear that this quantity rather corresponds to two equivalents.

† Although we acknowledge, with M. Berthelot, that the law of Dulong and Petit, when applied to solids, is not rigorously exact, and that it cannot serve, in an absolute manner, for the determination of atomic weights, still we believe that he exaggerates the exceptions which it suffers, and that it must be taken into account in the case of elements whose physical properties are very similar, as in the case of metals whose fusion-points are not very far apart.

each compound. This new law is no other than the third principle of the author, which has already been stated, the law of maximum work.

Whence the division of this volume in two parts:

The first treats of what may be called chemical dynamics. It is the study of combination and decomposition, and contains definitions of the opposing actions, on one side, of chemical forces, and on the other side, of calorific, luminous, and electric energies, which determine the phenomena. In this way, the conditions are laid down which determine the existence and the stability of combinations for each separate body.

The second part is the study of the final state which results from reciprocal actions between simple and compound bodies; this is chemical statics. In this part comes into action the principle of maximum work, which is as remarkable for its simplicity as for its generality. It brings everything down to the knowledge of two things: the heat given out by the transformations, and the stability which belongs to each compound.

The author demonstrates the existence of this principle, by the discussion of the general phenomena of chemistry; afterwards, he develops the application of it to the reciprocal actions of the principal groups of substances, such, for instance, as take place between elements and binary compounds; the reciprocal displacement of binary compounds, and specially of hydracids, when opposed to one another or to water; the reciprocal displacements of acids in salts, and, finally, saline double decompositions.

It may be easily understood that it is impossible to give, in a review of this kind, a clear idea of a work of such importance and of such vast extent. We have only tried to give an idea of the subjects treated in it. The theories of M. Berthelot are well known, as they have been developed by him for the last sixteen years in a series of papers, which have been read by all chemists. Nevertheless, the present work forms an important epoch in the history of chemistry, and shows the necessity of transforming its methods. In the future, it will not be sufficient to state the reactions of which a body is susceptible, as if they were mere experimental data. It will be necessary to derive them from the general principles, of which these reactions are consequences. Doubtless, the edifice of chemical mechanics, whose foundations have been laid by M. Berthelot, cannot be considered complete. Sixty years ago, the laws which govern chemical proportions were established, and nevertheless, the numbers which represent equivalents have frequently to be rectified. We may expect that those which express the quantities of heat of combination, or transformation, will also require change, more especially as many of them cannot be determined directly by experiment, but result from complicated calculations in which a great number of reactions have to be taken into account.

There are, moreover, many theoretical questions of the highest importance, the solution of which is at present beyond our reach.

If the heat given out in the combination of two bodies is the immediate consequence of the loss of momentum which comes from the union of their particles, and if it measures at the same time their mutual affinity, what then is the first cause of affinity? Is it a special force as was once believed? Or is it the concordance in the vibratory motions of the particles?

Those combinations which are attended with evolution of heat are the only ones which can take place directly; but they do not always take place spontaneously. Many of them must be determined by an exterior cause, such as heat, light, electricity, but these agents do not give to the elements an energy of which they have already an excess. How then do they act?

These questions, and many others which will come up, cannot fail to exercise for a long time to come the sagacity of chemists. At any rate, an important step has been made towards their solution when it has been shown that the physical and chemical energies which come into play in chemical reactions, follow the laws of rational mechanics.—*Journal of the American Chemical Society.*

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Physical and Mathematical Section.

April 13, 1880.

E. W. Binney, F.R.S., F.G.S., President of the Section, in the Chair.

"*Colorimetry, Part IV.*," by James Bottomley, D.Sc.

On the Colour Relations of Nickel and Cobalt.

For some experiments which I was making in colorimetry I wished to obtain a solution which would absorb all the kinds of light in the same ratio, so that whatever sort of light we started with, after penetration through such a solution, it would remain the same in character, the only variation being a change in intensity. Hence through such solutions white surfaces would appear grey of various shades, verging towards blackness as the length of the column increased. Such a fluid we might call a soluble black. I am not aware of any single fluid that fulfils the above conditions. It might be said, Why not use ink? but such specimens of ink as I have examined are bluish or violet on copious dilution. Moreover, the colour alters with the degree of oxidation; also, it seems to be colouring matter in suspension rather than in solution. I had some hopes of succeeding by mixing solutions of nickel and cobalt salts. On reference to the *Phil. Mag.*, vol. vi., p. 15, I find that the colour relations of nickel and cobalt had been studied by Mr. Thomas Bayley with a view to the quantitative determination of these metals founded upon the complementary character of their colours. He states, "The fact will have been observed by chemists that solutions of nickel and cobalt salts are so far complementary in colour that when they are mixed together the resulting liquid, if moderately dilute, is hardly to be distinguished from pure water." After considering the nature of the absorption spectra of nickel and cobalt salts, he states—"If the spectra were exactly complementary, on superimposing the nickel spectrum upon the cobalt spectrum the dark part on the one would cover exactly the light part on the other. This, however, though nearly the case, is not exactly so . . . this is why the solution obtained by mixing strong solutions of nickel and cobalt is not grey, but reddish brown in colour." Some experiments which I made seemed to confirm the opinion of Mr. Bayley; the nickel solutions contained 0·05 grm. of $NiSO_4$ per c.c., and the cobalt solution contained 0·05 grm. $CoSO_4$ per c.c. A mixture consisting of 50 c.c. of cobalt solution with 100 c.c. of nickel solution contained in a white porcelain basin seemed to be a grey tinted with pink in the shallower parts, and having a tendency to pass into a yellowish tint as the depth increased. I now poured the fluid into a tall glass cylinder covered externally with black cloth except a circular aperture of 8 m.m. diameter at the bottom. When I looked through the column of fluid at a white surface the colour was decided, resembling somewhat the pigment known as yellow ochre. Also, with a less proportion of cobalt to nickel—namely, 20 c.c. of cobalt solution to 50 c.c. of nickel solution—I still obtained a tint in which yellow seemed to predominate. Had I employed solutions so dilute that no colour was perceptible in the mixture, this would not strictly imply that the colours were complementary, but that the resulting tint was too feeble to produce the impression of colour, and if we filled a long tube with such a dilute solution the colour

might again become manifest. Moreover, my aim was not to mix two coloured solutions so as to obtain a fluid which exercised no perceptible absorption of light, but to obtain a fluid which would exercise a considerable absorption subject to a certain condition. The following consideration seemed to me to render it hopeless to obtain a soluble black by nickel and cobalt only. A solution of cobalt when dilute is pink, but if we look through a considerable thickness or through a concentrated solution, the pink shows a tendency to pass into scarlet. This shows that as the quantity of the salt increases the ratio of the yellow to the red increases. The colour of the undissolved salt is brownish red, and the colour of the solution seems to approximate towards this as the concentration increases. Hence the colour of a solution of cobalt alters not only in intensity but also in kind as the amount of the salt is increased. On the other hand, the green of a solution of nickel varies in intensity, but does not seem to vary in character, at least in any marked manner, as the quantity of the salt increases. In order that it should be generally complementary in character to cobalt, any inconstancy in the ratio of the red to the yellow of the latter would require a corresponding variation in the ratio of the yellow to the blue in the former, and the tint ought to pass from an emerald green to a bluish green. As this does not seem to be the case, it would follow that if we mixed nickel and cobalt so as to obtain a perfect grey for a column of definite length, a column longer or shorter than this would still retain some colour. My experiments seemed to indicate a deficiency of blue in the mixture, and this I thought might be supplemented by another salt; so I tried the addition of sulphate of copper. After some trials I got a solution containing in 1000 c.c. 7·275 grms. $NiSO_4$, 4868 grms. $CoSO_4$, and 11,468 $CuSO_4$; the solutions also contained 30 c.c. of strong sulphuric acid; this I added to guard against any possible formation of sub-salts on copious dilution. This solution seemed nearer to what I wanted than a solution of nickel and cobalt only. It did not, however, appear wholly free from colour, and possibly a variation of the quantities might have given a better result; also the tint seemed to vary somewhat with the nature and intensity of the incident light. When in the failing light of approaching evening I held the containing bottle against the grey sky I thought that there remained a somewhat pinkish tint, whilst in the colorimeter, when looking at an external white surface through a column sufficiently long to produce a perceptible absorption, I thought the solution had a bluish tint. When viewed against gaslight it gave a greenish tint. Within the range of coloured fluids in chemistry there may be some which if combined would yield a mixture absorbing all colours in the same ratio, so as to be truly a soluble black. The preparation of such a fluid would be an interesting problem in physics. It seems to me that we might also have such fluids which, on spectral analysis, would show not an absorption of all colours in the same ratio, but would be resolved into a violet and yellow, or an orange and blue, or red and green, or some other combination of colours of a complementary character.

Remarks on the Formulæ for the Intensity of Light that has passed through Absorbing Media, and on a Method of Experimental Verification.

In my last paper on colorimetry I pointed out that the function which expresses the connection of the intensity of light with the quantity of colouring matter is of the same form as the function expressing the relationship of the intensity and the length of the absorbing column, and if we accept Herschel's formula $\Sigma a k^t$ for the latter relationship, then an expression of the form $\Sigma a \kappa^Q$ must be taken to express the former relationship. The connection of these two may be shown more directly than I indicated in my last paper. If we grant one of the laws, the other may be deduced from it as a corollary. Take, for instance, the law as given by Herschel,—

$$T = a_1 k_1^t + a_2 k_2^t +, \&c.$$

Now it is manifest that if q be the quantity of colouring matter per unit of length, we may write the above formula

$$T = a_1 k_1^{q\frac{t}{q}} + a_2 k_2^{q\frac{t}{q}} +, \&c.$$

For—

$$k_1^{\frac{1}{q}}, \quad k_2^{\frac{1}{q}}, \quad k^{\frac{1}{q}}, \&c.,$$

substitute new constants, κ_1, κ_2, κ_3, &c. Then we may write—

$$T = \Sigma a \kappa^{qt}.$$

Since q denotes the quantity of colouring matter per unit of length, and t the total length, we shall have $Q = qt$, when Q denotes the whole quantity of colouring matter, so that we finally deduce—

$$T = \Sigma a \kappa^Q.$$

As the basis of a method of colorimetry, I took the relationship, that the length of the column was inversely as the quantity of colouring matter present when the colour was made constant. It may be readily shown to be a consequence of the laws stated above. Suppose C to be the constant colour, then—

$$C = \Sigma a k^{qt}.$$

The form of the equation shows that C is the sum of a number of constants, C_1, C_2, C_3, &c., such that—

$$C_1 = a_1 k_1^{qt}$$
$$C_2 = a_2 k_2^{qt}$$
$$\ldots = \ldots$$
$$C_n = a_n k_n^{qt}$$

whence we obtain—

$$\log \frac{C_1}{a_1} = qt \log k_1$$
$$\log \frac{C_2}{a_2} = qt \log k_2$$
$$\ldots\ldots = \ldots\ldots$$
$$\log \frac{C_n}{a_n} = qt \log k_n$$

and by addition we obtain—

$$\log \frac{C_1}{a_1} + \log \frac{C_2}{a_2} + \&c. = qt (\log k_1 + \log k_2 + \&c.)$$

Or—

$$qt = \frac{\log \left(\frac{C_1 C_2}{a_1 a_2} \ldots\ldots \frac{C_n}{a_n} \right)}{\log (k_1 k_2 \ldots\ldots k_n)} = \text{constant}.$$

In my last paper I stated that the law of absorption of light given by Herschel appears to have been obtained *à priori*; I have not found in his memoirs any experimental confirmation of it. The form of the expression has a somewhat formidable appearance, inasmuch as it involves the measurements of infinite varieties of light. But suppose that in the formula $\Sigma a k^t$, k is the same for every species of light; then we may write $T = k^t \Sigma a$ or $T = k^t I$, if I denote the incident light. In such a case the emergent light will be of the same nature as the incident light, and will differ only in intensity. Suppose the incident light to be white, the emergent light will be a white of less intensity—that is, will be a grey, approaching to blackness as the length of the column increases. A fluid medium, affecting white light in this way, we might call a soluble black, and my aim in seeking to obtain such a fluid was to apply it to the confirmation of the law. In a previous note I state that I had tried to obtain such a body; what I got was not wholly satisfactory, but I thought that with it I might obtain some approximate results. The solution I used consisted of 500 c.c. of the previously-mentioned fluid with 500 c.c. of distilled water.

The mode in which I proposed to operate was as follows:—Take two white lights of different intensities, say

W_1 and W_2, and look at them through the liquid. Suppose the lengths of the columns when equality of intensity is obtained to be t_1 and t_2, then—

$$W_1 k^{t_1} = W_2 k^{t_2}$$

Suppose we alter the lengths of the columns, and in a second experiment we find—

$$W_1 k^{t_1} = W_2 k^{t_2}$$

by cross multiplication and elimination of the common factor $W_1 W_2$ we obtain—

$$k^{t_1}\ k^{t_2'} = k^{t_2}\ k^{t_1'}$$

or, as we may write it,—

$$k^{t_1+t_2'} = k^{t_2+t_1'}$$

Then taking the logarithms of both sides and dividing by log k we get finally—

$$t_1+t_2' = t_2+t_1'.$$

In this way I proposed to test the law.

I took, as standard tints, a smooth surface of $BaSO_4$, and another of $BaSO_4$ and carbon, in the proportion of 10 grms. of $BaSO_4$ to 0·006 grm. of carbon: these materials were intimately mixed, and the powder reduced by pressure to a flat surface. The colorimeters used were glass cylinders covered externally with black cloth, the circular apertures at the bottom admitting light being 8 m.m. in diameter.

One experiment gave the following results:—Length of column 22·2 c., standard tint $W_1(BaSO_4)$, I now attempted to get the same intensity when looking through the second cylinder at tint W_2 ($BaSO_4$+carbon). The mean of two trials gave 14·8 c. as the equivalent column. Hence we have the following results:—

$$W_1 k^{22·2} = W_2 k^{14·8}.$$

I now made the length of the column over W_1 13 c. The equivalent column over W_2 was as the mean of two trials 7·5. Hence—

$$W_1 k^{13} = W_2 k^{7·5}.$$

From these experiments we get as the sum of t_1 and t_2' 29·7, and the sum of t_1' and t_2 27·8.

A second experiment gave—

$$W_1 k^{13} = W_2 k^{6·55}.$$
$$W_1 k^{22·2} = W_2 k^{15·45}.$$

Here $t_1+t_2' = 28·45$ and $t_2+t_1' = 28·76$.

A third experiment gave—

$$W_1 k^{16·8} = W_2 k^{10·65}.$$
$$W_1 k^{14·3} = W_2 k^{8·5}.$$

Here $t_1+t_2' = 25·3$ and $t_1'+t_2 = 24·93$.

A fourth experiment gave the following results—

$$W_1 k^{22·2} = W_2 k^{14·9}.$$
$$W_1 k^{12·5} = W_2 k^{6·2}.$$

Here $t_1+t_2' = 28·4$ and $t_1+t_2' = 27·4$.

A fifth experiment gave—

$$W_1 k^{25·1} = W_2 k^{16·65}.$$
$$W_1 k^{13·7} = W_2 k^{6·85}.$$

Here we have $t_1+t_2' = 31·95$ and $t_1'+t_2 = 30·35$.

It seems to me that the above results are as favourable as might be expected considering the difficulties of the enquiry; and even if all external circumstances necessary for the successful completion of such experiments had existed, there would yet remain the difficulty of deciding about the equality of two grey tints. In such matters it is difficult to say where judgment ends and fancy begins.

That any discrepancies might be due to such a cause was shown by the following experiments:—I took the two cylinders, and poured from one into the other with the intention of obtaining the same tint in both. In one trial I could not very clearly distinguish a column 16·4 c. long from one 14·6 c. long, and in a second trial a column 16·2 c. long seemed to give the same tint as a column 14·6 c. long. In the above experiments I used one eye only, namely, the right one.

I also made the following experiments:—I took as the standard of intensity W seen through a column 12·5 c. long. On a former occasion I had made 6·2 as the equivalent column to be used with W_2. On the present occasion I thought 6·5 gave a nearer result, so I took the column at this length. Now if the law of absorption of light be true, if we increase both columns by the same quantity, the intensities should again correspond. So I added 4 c. to each, making one column 16·5 and the other 10·2. I thought that the tints were the same. I now made one column 20·5 and the other 14·2. Again I thought the tints were the same. Finally, I made one column 24·5 and the other 18·2. The tints seemed again to correspond.

THE AMERICAN CHEMICAL SOCIETY.*

The June Conversazione of the Society was held with Dr. C. T. Chandler at the School of Mines, Columbia College, New York, on Thursday evening, June 20. A large attendance answered Dr. Chandler's invitation, and a pleasant time was spent examining a number of new additions to the Chemical Museum of the School of Mines.

Among the most interesting of the objects exhibited was a collection of the celebrated Arita porcelain from Japan. This material is true porcelain, made by the admixture of two natural clays found in Japan, without any preparation or other material. It is susceptible of being worked into the most delicate and artistic forms, and is decorated with all the beautiful and curious skill so characteristic of the Japanese.

Dr. Chandler explained the elaborate fittings recently put into the Chemical Lecture Room of the School of Mines for experiments with the electric light. These are so arranged that the room is lighted with two electric lamps, suspended from the ceiling and enclosed in opal glass globes; while by means of an ingeniously devised switch, at the side of the Lecture Table, these lamps can be thrown out of the electric circuit, and at the same instant the current is diverted to the experimental lantern to project objects on the screen. The advantage of this arrangement is that the sudden change from the electric light of the experimental lantern to gas-light, as ordinarily arranged for lecture rooms, is obviated, and there is no sudden strain upon the eyes. The electricity is obtained from a Wallace dynamo-electric machine, located in the Engine Room of the School of Mines, which machine is driven at a speed of about eight hundred revolutions per minute. Eight wires run from the different parts of the machine to the switch-board in the Chemical Lecture Room, thus giving the means of throwing out or using any desired combination of parts. With the lantern Dr. Chandler made a number of experiments in spectrum analysis, showing the lines of silver, copper, zinc, and the reversing of the sodium line. He also showed the effect of the change of form in the slit of the lantern, by using Dr. Henry Morton's admirable contrivance to form round disks, circles, and zig-zag lines of the spectrum on the screen.

Some beautiful examples of the Autotype Process of Photo-printing were exhibited, and much admired for their near approach to ordinary fine photographs, experts only being able to detect that they are printed.

A very fine and large photograph of Lauynmantel's picture of the arrest of Lavoisier by the Officers of the French Revolution was much admired.

Among a number of other minor objects exhibited were some old hand-blocks used in calico-printing. Dr. Chandler said he had visited a print-works, where he found a cord of such blocks stored away among some rubbish, and he secured some of them as relics of a process which is rapidly becoming obsolete, being superseded by the more modern process of machine-printing.

* Communicated by Arthur H. Elliott, F.C.S., Recording Secretary.

The next regular meeting of the Society will be held on Thursday, September 2, 1880.

NOTICES OF BOOKS.

The Life of Thomas Wills, F.C.S., Demonstrator of Chemistry, Royal Naval College, Greenwich. By His Mother, Mary Wills, and her Friend, J. Luke. London: James Nisbet and Co.

We have here an interesting account of the short career of a young chemist, whose researches have been, from time to time, recorded in the Chemical News, and who, had he survived, would have earned for himself no mean position in the scientific world. The volume includes several of his memoirs and lectures, such as a paper on the "Solidification of Nitric Oxide," read before the Chemical Society, February 20, 1873; an account of a new ozone generator, described in the Chemical News, vol. xxvii., p. 292; a paper on the "Theory of the Spontaneous Generation of Life," communicated to the Westminster Young Men's Association, February 4, 1875; an account of the coal brought home by the late Arctic Expedition, read at the Plymouth Meeting of the British Association (1877); a paper on the "Production of the Oxides of Nitrogen by the Electric Arc in Air,"—a subject upon which he was working at the time of his death—and a course of lectures on "Explosions in Coal Mines," delivered before the Society of Arts in January and February, 1878. In all these productions he appears as a sound chemist and as a clear, highly cultivated, and original thinker. Perhaps the only occasion where he suffered his judgment to be warped was in his paper "More Light," where he comes forward as the champion not merely of gas, but of gas companies, and proclaims the strong public feeling against them an "unreasonable prejudice." The very fact that a gas company, in applying to Parliament for additional powers, has attempted to stipulate that the gas should only be analysed at the works, and *after two hours' notice had been given*, is more than sufficient to justify "prejudices" against such bodies. What would be thought of a shopkeeper who should petition for two hours' notice of the visit of the inspector of weights and measures?

The immediate cause of the premature death of Mr. Wills was typhoid fever, but he had been declining in health for some months previously, and there can be little doubt that overwork was the root of the mischief. His love for science was a perfect passion, and he was most conscientious in the fulfilment of his duties. But he had undertaken too much. One feature in his activity deserves in particular honourable mention. Whilst combatting that materialistic tendency with which science is in some quarters tainted, he ever sought to combat that jealousy with which the progress of research is viewed in the religious world.

University of Tokio: the Calendar of the Departments of Law, Science, and Literature. 1879-80. Tokio: Z. P. Maruya and Co.

This publication throws an interesting light on the progress of higher education in the Japanese Empire. Of the fifteen professors in the faculty of science four are native Japanese, the remainder being composed of four Americans, two Germans, two Frenchmen, and two Englishmen, perhaps the only instance outside the British Empire where a professorship other than of the English language and literature is held by persons of this nationality. The general arrangements of the University are rational. Not only are the three departments of faculties in fact separate institutions, but in the department of Science there are five distinct courses. These are—Chemistry; mathematics, physics, and astronomy; biology; engineering; geology and mining. These courses, however, are for the first year all identical; but for the remaining three years each student is required to elect one of the courses and pursue as his special studies those of the course chosen. Thus the error of "all-roundism," and the superficiality which it necessarily entails, are avoided. The common curriculum for the first year embraces the English language, logic, outlines of mental philosophy, mathematics, elementary mechanics, outlines of astronomy, inorganic chemistry, elementary mineralogy, elementary geology, and drawing. Each curriculum becomes increasingly special as the student advances, and in every case a graduating thesis is required at the close. In other words, the pupils are required to prove their capacity for research in the subjects they have selected, and cannot, as is unfortunately the case in England, attain honours by dint of mere verbal memory. In every course, however, Japanese and Chinese literature figures among the last year's studies—a requirement of doubtful value to a man of science.

It may be interesting to quote the questions in chemical technology given in the second examination of the fourth year:—

1. Give the usual dimensions of O. V. chambers, and show how you would arrange a series of five so as to get the most concentrated acid possible.
2. What chemical examinations are made in this process, and how.
3. Give a brief description of the Stassfurt salt-deposits.
4. Describe the construction of Mactear's carbonator.
5. What processes have been used for the recovery of the sulphur contained in tank-waste. Describe two of them briefly.
6. Describe the methods called respectively Dunlop's and Weldon's methods, used for recovering manganese from the still-liquors.
7. How is iodine obtained from kelp by Stanford's process.
8. Give an outline of the Stassfurt method of preparing bromine.

We do not find any mention of the graduating theses submitted by the students in any of the departments of the scientific faculty—an important omission, as such documents would have been the most satisfactory data concerning the real efficiency of the University.

Memoirs of the Science Department, University of Tokio, Japan. Vol. I., Part I. "Shell Mounds of Osmori." By E. S. Morse, Professor of Zoology, University of Tokio.

This memoir contains much to interest the zoologist, the antiquarian, and the anthropologist, but, as may be judged from the title, nothing of a chemical or a physical nature. Not merely the printing of the book, but the drawing and lithographing of the plentiful illustrations, have been executed, and that very satisfactorily, by Japanese artists and artisans.

CORRESPONDENCE.

CELLULOID.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol xlii., p. 10, in answer to a question from a correspondent "What is Celluloid, how prepared &c.," you state that it is the invention of D. Spill. Such is not the case, as it is the invention of Alexander Parkes, of Birmingham, who patented it in 1855, and has taken numerous patents since for improvements upon the original mode of manufacture and for a variety of applications, and after whom it was for some time called "Parkesine," and a company was formed called the Parkesine Company Limited, of which D. Spill was the working manager.

Will you kindly insert this correction, in order that the merit of the discovery may be awarded to the real inventor. Medals were awarded to Mr. Parkes for the discovery, at the English Exhibition of 1862, and the Paris Exhibition of 1867.—I am, &c.,—

Alexander Parkes.

3, Wellington Terrace, Sutton Coldfield,
July 19, 1880.

DIAZO-COLOURS WITH MORE THAN TWO SULPHO-GROUPS.

To the Editor of the Chemical News.

Sir,—In the account of the Proceedings of the American Chemical Society (Chemical News, vol. xlii., p. 44), there is a report of a paper by Mr. J. H. Stebbins on "*Some New Colouring Matters produced by the Action of Diazo-compounds on Phenols*," wherein the author lays claim to the introduction of more than two sulpho-groups (HSO_3) into these colouring matters as a novelty. Permit me to point out, through your columns, that last year I took out a patent (May 10, 1879, No. 1864), in which I describe the production of such colours, formed by the action of diazo-sulphanilic and its homologues on the salts of the disulphonic acid of β-naphthol, &c.—I am, &c.,—

R. Meldoda.

Atlas Works, Hackney Wick, London, E.,
July 26, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 1, July 5, 1880.

Photography of the Chromosphere.—M. Janssen.—By pursuing the method of reversing images by a prolonged exposition, which I communicated to the Academy at its last session but one, it seems to me that we may succeed in obtaining the photograph of the chromosphere. The luminous solar action must be continued long enough to become positive to the borders without going beyond them. The chromosphere then appears in the form of a black circle, the diameter of which corresponds to 8″ or 10″. I have compared positive and negative solar photographs obtained the same day with the same instrument, and the measure of the diameters shows that the black circle in question is clearly outside the solar disc.

The Consequences of the Experiment of MM. Lontin and Fonvielle.—M. Jamin.—A mathematical paper, not adapted for abstraction.

Vision of Colours.—M. Chevreul.—The author presents to the secretaries a letter addressed to him in 1846 by Colonel Baron Aubert, accompanied by five transparent designs caused by bands of superimposed paper. The optical effects of silk tissues, which form a small octavo volume of lectures delivered at Lyon in 1842 and 1843, are reduced to four principles which it is well to recall.

General Relations between the Chemical Mass of the Elements and the Formation-heat of their Compounds.—M. Berthelot.—Elements belonging to one and the same group, when they unite with a given simple body to form comparable compounds, evolve, in the majority of cases, quantities of heat, so much the less as the chemical mass of these elements is more considerable; the stability of the compound decreases in the same proportion. The decrease sometimes extends as far as a change of volume produced by the combination of solid elements, forming a compound likewise solid.

On a Meteorite which fell November 26, 1874, at Kerilis, in the Commune of Mael-Pestivien, Canton de Callac (Côtes-du-Nord).—M. Daubrée.—The meteorite when entire weighed about 5 kilos., and had been driven into the soil to the depth of 0·78 metre. Its sp. gr. is 3·51. The portion of the mass soluble in hydrochloric acid consists of peridot, pyrrhotine, and nickel iron.

On a Meteorite which fell September 6, 1841, in the Vineyards of St. Christophe-la-Chartreuse in the Commune of Roche-Servières (Vendée).—M. Daubrée.—This meteorite weighs 5·5 kilos., and is unfortunately in the hands of a local *propriétaire*, who refuses to part with it.

Nature of the Immunity of Algerian Sheep against Splenic Fever.—A. Chauveau.—All the indigenous sheep of Algeria enjoy in a more or less marked degree an immunity against this infection, and can communicate it by crossing to European sheep. French sheep do not acquire it by living and propagating in Algeria, and it is not known whether it may not be lost by Algerian sheep propagated in France.

Brilliant Spectral Rays of the Metal Scandium.—R. Thalén.—The rays of scandium are very characteristic, both by their arrangement and their lustre. They are almost all very fine, except certain rays in the yellow and orange portion and the seven strong rays situate in the blue-violet part of the spectrum and which have a certain width. Among these latter there is one, 4374, O, which the author suspected might coincide with a strong ray of yttrium. But on a direct comparison there is found a small but distinct difference of position. The scandium ray is the more refrangible. There are also in this spectrum certain very faint bands between 5900 and 5730. According to the view of Angström these bands may be due to the oxide of the metal.

Improvements in Coils of the Siemens Type.—G. Trouvé.—The polar surfaces, instead of being portions of a cylinder whose axis coincides with that of the system, are in the form of a helix, so that whilst turning round they gradually approach the surface of the magnet up to the point where the posterior margin escapes the pole of the magnet. The action of repulsion then begins, so that the dead point is practically avoided.

The Sensibility of the Eye to Differences of Light. A. Charpentier.—The eye appreciates much better the differences of intensity of two contiguous lights than the differences of two successive lights, since in the latter case the differential sensation is seven to eight times stronger than in the former, in which it is not more than 1-100th part. The sensibility of the eye is constant for the whole extent of the retina.

Thermic Researches on the Ammonium Polysulphides and Hydrogen Persulphide.—P. Sabatier.—The formation-heats of the three polysulphides, if formed from their elements, are given as +34·53, +34·73, and +34·83 calories respectively. Hydrogen persulphide is formed with absorption of heat, like oxygenated water.

The Density of the Vapour of Iodine.—L. Troost.—The density of the vapour of iodine decreases as well at low as at high temperatures. All the hypotheses which have been formed, based either upon a dissociation of iodine or upon an isomeric change, appear to me not very admissible. In the present state of our knowledge nothing warrants us to suppose that a partial vacuum suffices to produce a modification of this nature. The only consequences which necessarily flow from the experiments made at high temperatures or at low pressures, are that the coefficient of the expansion of iodine is variable with the temperature, and that its coefficient of compressibility varies with the pressure. All the hypotheses proposed to explain these results should take this double variation into account.

The Atomic Weight and some Characteristic Salts of Ytterbium.—L. F. Nilson.—As the mean of seven determinations the author gives the atomic weight of ytterbium as 17·301. Ytterbia, Yb_2O_3, is a white infusible powder, of sp. gr. 9·175. It is insoluble in water, but dissolves readily in acids, even if dilute, with the aid of heat. It is not readily attacked in the cold even by concentrated acids. The solutions are colourless, and do not present any absorption-ray. The earth and its salts do not impart any colouration to flame. The anhydrous sulphate is an opaque mass which does not lose all its sulphuric acid below a white heat. The aqueous sulphate forms large brilliant prisms, permanent in the air, but which lose their water at 100°.

The Solution of Platinum in Sulphuric Acid.—M. Scheurer-Kestner.—The author concludes from his experiments that absolutely pure sulphuric acid does not attack platinum, and that by making use of ammonium sulphate as recommended by Pelouze we may almost completely avoid injury to platinum vessels. Sulphuric acid containing traces of nitrous acid dissolves platinum, and the activity of this process increases with the concentration of the process. The acid from the lead chambers, even when containing an excess of sulphurous acid, attacks platinum, the nitrous acid resisting the action of the sulphurous acid, and being in a state of stable combination. Hence the corrosion of platinum is always due to the presence of nitrogenous compounds in sulphuric acid. One part in 10,000 suffices to dissolve a proportion of platinum such as is never observed industrially. To ascertain whether an acid is sufficiently free from nitrogenous compounds the most sensitive reactions are necessary. An acid in which ferrous sulphate scarcely reveals visible traces of nitrogen compounds is coloured blue by diphenylamine. It contains both sulphurous and nitrous acids, and it attacks platinum. During its concentration the quantity of nitrous acid scarcely diminishes, whilst the sulphurous acid is completely expelled.

Remarks on the Etherification of the Hydracids.—A. Villiers.—Etherification results from the equilibrium established between the hydrates which the acids form with water, and the alcoholates or combinations which they form with alcohol, both these classes of bodies being in a state of partial dissociation.

Atmospheric Bacteria.—P. Miquel.—The number of atmospheric bacteria is low in winter, rises in spring, reaches its maximum in summer and autumn, and falls rapidly with the first frosts. This law is equally applicable to the spores of fungi. But whilst the mould germs are most abundant in damp weather, the aërial bacteria are then rare, and become most numerous when the ground is dry. Until it shall be possible to prepare a liquid capable of causing the germs of all Schizophytes to germinate indiscriminately, it will be very difficult to find with accuracy the number of bacteria suspended in the air. On operating with neutral broth perfectly sterilised the mean annual number of bacteria found in a cubic metre of air does not exceed 200, which would lead us to believe that the atmosphere is a hundred times richer in spores of moulds than in germs of bacteria. In summer and autumn we find occasionally at Montsouris 1000 germs of bacteria per cubic metre of air. In winter it is not rare to see this number fall to 4 or 5, and to notice days where the dust of 200 litres of air is incapable of setting up infection, even in the most susceptible liquids. In the interior of houses, in the absence of mechanical causes which stir up dust, 30 to 50 litres are required to determine infection. In the author's laboratory 5 litres are sufficient to infect neutral broth. 1 litre of air from the sewers of Paris is enough to occasion a similar result. It will be seen how widely these results differ from those published by Prof. Tyndall. According to this *savant* a few c.c. of air are generally sufficient to introduce infection into the most various liquids. The author has compared the mortality in Paris due to infectious diseases with the number of bacteria present in the air. From this comparison, carried on from December, 1879, to June, 1880, it appears that every increase of atmospheric bacteria is followed in about eight days with an increase of the deaths from this class of diseases. Prolonged observation must prove whether this fact is anything more than a coincidence.

A Digestive Ferment in the Juice of the Fig Tree.—M. Bouchut.—The researches undertaken by the author in connection with Prof. A. Wurtz on the juice of *Carica papaya* have induced him to inquire whether the properties of papaïne are not connected with a general carnivorous property in the juices of many other plants. For the present he has established this property as existing in the milky juice of the fig tree. This juice is scanty and difficult to collect, and its properties vary in quality according to the more or less advanced stage of vegetation. The author's experiments were made with juice from Provence, collected in the month of April. 5 grms. of the partially coagulated juice were placed in a glass with 60 grms. of distilled water and 10 grms. moist fibrine, and exposed to a temperature of 50°. By evening the fibrine was completely digested. 10 more grms. of fibrine were then added and digested in twelve hours; then 12 grms., then 15 grms., at intervals of a day or two, until 90 grms. fibrine had been acted upon. The solution had a decided odour of good meat-broth, free from putridity.

Justus Liebig's Annalen der Chemie,
Band 202, Heft 1.

Phenyl-naphthyl-carbazol.—C. Graebe and W. Knecht.—The authors have obtained this compound from the pitch remaining after the distillation of anthracen. They have also obtained it synthetically by passing β-phenyl-naphthylamine through a strongly-heated combustion-tube. It possesses no basic properties, but forms an unstable compound with picric acid. Phenyl-naphthyl-carbazol sublimes in leaflets, melts at 330°, and boils about 450°. It is almost insoluble in cold alcohol and benzol, but dissolves readily in boiling aniline.

Vapour-Determinations in the Vapour of Phosphorus Penta-chloride.—The author gives several determinations effected by this process.

The Compounds of Phthalic Acid with the Phenols (Second Memoir).—A. Baeyer.—This valuable paper, which extends to 110 pp. is quite incapable of abstraction.

Pereiro Bark.—O. Hesse.—The author finds in this bark the following bases, which are here described:—Geissospermine, $C_{19}H_{24}N_2O_2$; pereirine, $C_{19}H_{24}N_2O$; and a base not yet named, $C_{16}H_{18}N_2O$.

Caroba Leaves.—O. Hesse.—These leaves are obtained not, as was supposed, from the tree yielding the pereiro bark, but from *Jacaranda procera*. They contain no basic compounds.

Remarks on Morphine Hydrochlorate.—O. Hesse.—The author has obtained and analysed an anhydrous hydrochlorate.

Band 202, Heft 2.

Combinations of Phthalic Acid with the Phenols (Third Memoir).—A. Baeyer.—This paper consists of researches on ortho-cresol-phthaleine and its derivatives, conducted by G. Fraude. The principal derivatives here described are diacetyl-ortho-cresol-phthalein, dibenzoyl-ortho-cresol-phthalein, dibrom-ortho-cresol-phthalein, dinitro-ortho-cresol-phthalein, methyl-oxy-anthraquinon, brom-methyl-oxy-anthraquinon, methyl-alizarin, diacetyl-ortho-cresol-phthalin, and dibrom-ortho-cresol-phthalin. The author then briefly notices the phthalidin and phthalidein compounds of ortho-cresol.

TO CORRESPONDENTS.

Brickmaker.—Not a chemical question.

THE JOURNAL OF SCIENCE

for July (Price 1s. 6d.), includes—

The Evolution of Scientific Knowledge. By C. Lloyd Morgan.
Habits and Anatomy of the Honey-bearing Ant.. By C. Morris.
The "Laws of Emphasis and Symmetry." By J. W. Slater.
Instinct and Mind. By S. Billing.
Tuberculosis transmissible through the Meat and Milk of Animals affected with it.
Natural Science and Morality. By S. Tolver Preston.
Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1880-81 will commence on FRIDAY, OCTOBER 1st, 1880. Four entrance Scholarships, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Entries on or before September 20. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other hospital appointments are free. The resident appointments consist of Five House Physiciancies, Four House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the Metropolis.

MUNRO SCOTT, Warden.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

SILICATE OF SODA, Solid and in Solutions of Various Degrees of Concentration: the finest quality obtainable, and especially adapted for the use of Soap Makers and other Consumers.—JOSEPH CROSFIELD and SONS, Soap Makers, &c., Warrington.

London Agent—H. B. CLARKE 37, Great Tower Street, E.C.

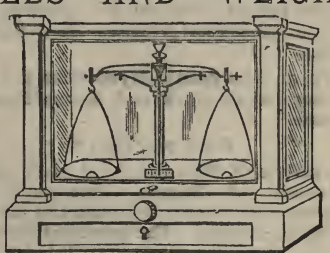
BECKER & SONS,

MANUFACTURERS OF

CHEMICAL AND GOLD ASSAY BALANCES AND OTHER

SCALES AND WEIGHTS.

ROTTERDAM.



NEW YORK.

BECKER'S STUDENT'S BALANCE, in polished mahogany glass case, sliding front, counterpoised, to carry 30 grammes in each pan and turn to ½ milligramme, nickel plated pans £2 10
Ditto, ditto, in mahogany glass case, polished black.. .. .. £2 13

Sole Agents for England, Ireland, and Wales:—

TOWNSON & MERCER.

Becker's Complete Lists forwarded by post on receipt of 1d. stamp or free on application.

SPECIALITIES.

Manganese.—Finest Crystallised, Lump, Ground, and Granulated of every quality, and PREPARED for *Chlorine, Glass, Steel, Ferro-Manganese, Pottery, Battery*, and EVERY PURPOSE.

Bauxite.—(Hydrate of Alumina) Of high percentage of Alumina and almost free from Iron. The CHEAPEST, BEST, and MOST PROFITABLE article from which to produce ALUM, ALUM CAKE, and SULPHATE OF ALUMINA, &c. [BRAND, "IRISH HILL BAUXITE."]

Fluor-Spar.—Of the Very Finest Quality for Acid, Soda, Glass Flux, and all purposes.

Barytes.—(Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

Cryolite.—Magnesite, Felspar, Arsenic, Phosphates, French Chalk, Strontia, Wolfram, Chrome, Terra-Alba, Rotten Stone, China Clay, Umbers, Ochres, Antimony, Calamine, Emery Stone, all Oxides, and all

Fuller's Earth.—Of superior quality, and entirely free from grit. [BRAND, "EMERALD."]

MINERALS, CHEMICALS, AND COLOURS.

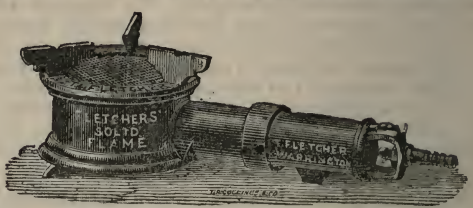
GEO. G. BLACKWELL,

MINE PROPRIETOR,

Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.

OFFICES—26 CHAPEL STREET, LIVERPOOL.

Fletcher's SOLID FLAME Burner.



The Most Perfect Heating Burner or all purposes. It will with equal ease boil an egg, or melt half-a-hundredweight of lead ir an iron pot. It will boil half-a-gallon of water in a flat copper kettle in six minutes, or melt 5 lbs. lead in an iron ladle in the same time. Price, nickel plated, 5s; japanned, 4s. It can be made at a low cost of *any shape, size, or power*. New and enlarged list of Gas and Petroleum Heating Burners, Forges, Furnaces, Hot- and Cold-Blast Blowpipes, Ingot Moulds, Foot and Hand Blowers, &c., price 3d., free by post.

THOS. FLETCHER,

4 & 6, MUSEUM STREET WARRINGTON.

C. H. GIMINGHAM'S PATENT COMBINATION BLOWPIPE

FOR AMATEUR & PROFESSIONAL GLASS-BLOWING, &c

AS USED IN L. CASELLA'S WORKSHOPS.

The difficulties of Glass-Blowing are reduced to a minimum by this instrument. It combines the use of the large or small flame and large Bunsen flame, the changes from one to the other being made in less than one second.

SOLE MAKER—

L. CASELLA, 147, HOLBORN BARS, LONDON, E.C.

ROYAL POLYTECHNIC.—Shakesperian Recitals: Scenes from "Hamlet" at 7.15 p.m. daily; and at 3.30 on Monday, Wednesday, and Saturday. Hamlet, Mr. Marlande Clarke; Ophelia, Miss H. Shea; The Queen of Denmark, Miss Eva Russell; Polonius, Mr. Heath; 1st Grave-Digger, Mr. Weatherhead. Lectures on the Phenomena of Nature, the Microscope, London, Phosphorescence, &c., &c. Ghost Entertainment, Blondin, the Wonderful Automaton. Admission, 1s.; Reserved Stalls 3s.; may be booked at all the Libraries.

TO BE LET OR SOLD, on moderate terms, the whole or any portion of a Works situate near Wolverhampton, in a good state of repair, and having an area of about an acre. There is a branch from a main line of railway running into every part of the Works, and an extensive frontage to a Canal Wharf. The use of neighbouring boilers and engines may be had if required. Adjoins Oil of Vitriol and Manure Works, and unused Phosphorus and Copper Extracting (wet process) Works.—Address, Messrs. Slater and Marshall, Solicitors, Darlaston, near Wednesbury, Staffordshire.

THE CHEMICAL NEWS.

Vol. XLII. No. 1080.

SOME OBSERVATIONS UPON THE HYDROLYTIC FERMENTS OF THE PANCREAS AND SMALL INTESTINE.*

By HORACE T. BROWN, F.I.C., F.C.S., and JOHN HERON, F.C.S.

We were requested a few months ago by Dr. W. Roberts to verify a statement, recently made by Musculus and De Méring, that *maltose* is a product of the action of an aqueous extract of pancreas upon starch-paste. During the prosecution of the inquiry, and whilst following up certain lines of experiment which suggested themselves from time to time, we have, besides fully confirming the results of the above-mentioned observers, ascertained certain facts which we believe are of some physiological importance in elucidating the still very obscure processes of animal digestion and nutrition.

I. *Hydrolytic Action of the Pancreas.*

The first observation upon the amylolytic action of the pancreatic secretion appears to have been made by Bourchardat and Sandras† in the year 1845. The general functions of the gland were more fully studied in 1856 by Claude Bernard,‡ and a few years later by Cohnheim (*Virchow's Archiv.*, 28, 241, 1863). Danilewski§ in 1862, and Hüfner (*Journal f. Prakt. Chem.* [2], 5, 1872, 396), ten years later, isolated a soluble amylolytic ferment from the pancreas, the former observer by acidifying the aqueous infusion with phosphoric acid and precipitating with lime; the latter by the glycerin method first described by Wittich.

Hüfner found that the isolated body, which was still doubtless impure, contained 14·95 per cent. of nitrogen, but a less quantity of carbon and a greater quantity of oxygen than an ordinary albuminoid.

Until recently it has always been taken for granted that the fermentable sugar produced by the action of pancreas upon starch-paste is dextrose. Nasse, however, in 1878 (*Pflüger's Archiv. f. Physiologie*, 14, 473), attempted to show that the fermentable and cupric-oxide reducing body, obtained by the action of saliva upon starch, is a specific sugar which he calls *ptyalose*, and that the action of pancreatic juice appears to result in the production of the same body. Nasse did not isolate this hypothetical sugar, nor even approximately determine its specific rotatory power, but relied mainly upon its non-reduction of Barfoed's solution, and its doubling in reducing power on boiling with dilute acid, as evidence of its non-identity with dextrose.

In the early part of last year Musculus and De Méring published an important memoir (*Bull. Soc. Chim.*, 31, 105), upon the action of diastase, saliva, and pancreatic secretion upon starch and glycogen.

They concluded from their experiments that the fermentable sugar produced in all these reactions is a mixture of maltose and dextrose. We have shown in a recent communication to the Chemical Society (*Journ. Chem. Soc.*, 1879, 1, 648; *Liebig's Ann.*, 199, 245), that *dextrose* can certainly not be included amongst the products of the action of malt diastase upon starch. The experiments we are about to describe will afford ample proof of the correctness of that portion of the above statement of Musculus and De Méring referring to the action of pancreatic extract.

Our experiments were made either with the aqueous infusion of the gland, or with the actual tissue itself in a finely divided state.

The first method is by far the most convenient, and is the one which we generally adopted when studying the action of the pancreas, but it will be seen that certain tissues can produce under some circumstances hydrolytic effects which their aqueous infusions are incapable of exercising.

With a clear aqueous infusion of the gland, the course of experiment did not differ materially from that which we employed when investigating the action of malt-diastase upon starch (*loc. cit.*). As a rule the infusion had no power of reducing cupric oxide, hence it was not necessary to apply any correction to the quantity of cupric oxide reduced by the transformation products.

In cases where the transformation was effected by the actual tissue itself, this was previously dried very rapidly in a current of air at 35° C., a process which could easily be carried out without decomposition taking place. The dried tissue was used with a given volume of the experimental liquid containing a known quantity of the carbohydrate. The volume of the liquid was kept constant during the experiment, and the small increase in solid matter due to hydration was taken into consideration. Far more accurate results are obtained by this method than by attempting to estimate the correction for the total solids by digesting a given weight of the tissue in a given volume of water. In the latter case the solvent action of the water upon the tissue always differed somewhat from the solvent action of the solution of the carbohydrate employed.

When a clear infusion of pancreas, obtained by acting for several hours upon one part of the finely divided pancreas of the pig with five parts of cold water, is added to starch-paste at 40° C., complete limpidity is produced with extreme rapidity, and in from ten to fifteen minutes iodine ceases to produce any reaction for soluble starch or erythrodextrin. Careful observations at different periods of the reaction showed unmistakeably that the transformation in its first stages does not differ in the least from transformations of starch-paste made at 60° C. with aqueous malt-extract, which has not been previously heated to a higher temperature. When the specific rotatory power of the transformation products has reached $[\alpha]_{j_3}$·86, 162°·5, the cupric-oxide reducing power is found to be κ 49—50. When about 3 cub. centims. of the pancreatic infusion have been used for every grain of starch, the time occupied in fully bringing about this change is from forty to fifty minutes. The liquid now contains *maltose*, and an achroodextrin having all the properties of our *achroodextrin ζ*.

The maltose was proved to be identical with that obtained by the action of malt-extract by isolating it in its characteristic crystalline form, and by determining its specific rotatory and cupric-oxide reducing powers.

The composition of the matter in solution at this point is

Maltose	80·8
Dextrin	19·2
	100·0

which is that required by our No. 8 equation.

$$\underbrace{10C_{12}H_{20}O_{10}}_{\text{Soluble Starch.}} + 8H_2O = \underbrace{8C_{12}H_{22}O_{11}}_{\text{Maltose.}} + \underbrace{C_{24}H_{40}O_{20}}_{\text{Achroodextrin } \zeta.}$$

On continuing to digest the liquid at 40° C., the values of $[\alpha]j$ and κ undergo a little alteration, which is, however, very slow when compared with the previously rapid degradation of the starch-molecule.

The following is an example of such an experiment:—

* A Paper read before the Royal Society, May 13, 1880.

† "Des Fonctions du Pancréas, et de son Influence dans la Digestion des Féculents," *Compt. Rend.*, 20, 1085.

‡ "Mémoire sur le Pancréas," 1856. "Leçons de Physiologie Expérimentale," Paris, 1856.

§ "Ueber specifisch wirkende Körper des Natürlichen und Kunstlichen Pancreatischen Saftes," *Virchow's Archiv.*, 1852, 25, 279.

90 cub. centims. of a liquid containing 3·5 grms. of starch-products, already reduced to the above point, were digested at 45° C. for twelve hours, with the further addition of 10 cub. centims. of fresh pancreatic extract.

At the end of that time, the liquid having remained perfectly free from organic life, the starch-products yielded on analysis the following corrected numbers:—

$[\alpha]_{j3\cdot86}$	128°·7
$\kappa_{3\cdot86}$	66°·8

corresponding very closely with the composition

Maltose	55·5
Dextrose	32·7
Dextrin	11·8
	100·0

The united evidence afforded by many such experiments as the above proves conclusively that the *prolonged* action of a pancreatic infusion yields results differing materially from those obtained under similar conditions with malt-extract. With malt-extract the hydrolytic effect upon the starch-products, after No. 8 equation is reached, is confined entirely to the conversion of the achroodextrin into maltose, the latter body being the final product of the reaction. On the other hand, an aqueous infusion of pancreas, whilst converting achroodextrin into maltose, sensibly hydrolyses the maltose to dextrose.

In order to put this important point of difference between the action of malt and pancreatic extract beyond all doubt, a solution of pure maltose was digested with an infusion of pancreas, in just the same manner as maltose had, on many previous occasions, been treated with malt-extract.

100 cub. centims. of a solution of maltose, containing 5·813 grms. of substance, were mixed with 20 cub. centims. of a clear aqueous infusion of pancreas, the infusion being added in successive portions of 5 cub. centims. each. Temperature of digestion 45° C.

In four hours the optical activity of the solution had fallen from $[\alpha]_{j3\cdot86}$, 150°·0, to $[\alpha]_{3\cdot86}$, 148°·7; and after sixteen hours to $[\alpha]_{3\cdot86}$, 135°·1; the value of κ at the end of this time having risen from 61 to 67·3. The composition deduced from these latter numbers is—

Maltose	83·8
Dextrose	16·2
	100·0

This experiment, repeated many times, always gave the same results, thus proving that the amylolytic agent of the pancreas is capable, as stated by Musculus and De Méring, of slowly converting maltose into dextrose, a property which is not shared by malt diastase. Both malt diastase and pancreatic diastase have, however, the property of hydrolysing the lowest acroodextrin of the series, a fact which we have proved by submitting to their action the isolated and purified achroodextrin ζ.

A series of experiments was now made with the object of ascertaining if the pancreas contains any ferment capable of inverting cane-sugar. It will be remembered that a cold aqeous infusion of malt possesses this property to a limited extent. The first experiments were made by digesting solutions of cane-sugar at 40° C., with 25 per cent of an aqueous extract of pancreas (5 of water to 1 of pancreas). As long as the solutions remained free from bacteria we never observed even the slightest inversion of the cane-sugar, the specific rotatory power of the solutions remaining constant throughout the experiment. If the digestion was carried on for a length of time sufficient to develop organic life, and a sensible evolution of gas, a marked inversion of the sugar set in, a result which is not however attributable to any soluble ferment derived from the pancreas.

From some observations made at a later period of the inquiry it seemed possible that the gland-tissue itself might have an effect which was not shared by its aqueous infusion. An experiment was consequently made in which the finely divided pancreas itself was digested with the cane sugar solution. Here again, however, as in the former case, absolutely no inversion took place.

J. Béchamp, in his experiments upon the action of various tissues upon starch-paste and cane-sugar, states that the pancreas has a very slight invertive action upon cane-sugar ("Les Microzymas," p. 68). In an examination of the details of his experiments, however, it is clear that he only obtained evidence of invertive action after the gland had been in contact with a sugar solution for several days, and in no cases without the previous appearance of bacterial life to which doubtless the effects are attributable; the invertive action of some of these organisms being almost as well marked as that of the Saccharomyces.

II. *The Hydrolytic Action of the Small Intestine.*

Claude Bernard first called attention to any distinct hydrolytic action of the small intestine. He found that a solution of cane-sugar, inclosed within a portion of the intestine ligatured above and below, or placed in contact with an infusion of its mucous membrane, speedily acquired the property of reducing a cupric solution.

Bernard found this property common to the small intestine of the dog, pig, rabbit, rat, and various other animals, and looked upon the invertive action as one of the most important functions of the *succus entericus*.

The observations made from time to time upon the *amylolytic* action of the secretions of the small intestine are somewhat conflicting. Thiry (*Wien. Sitzungsber.*, l., 77), in 1864, by isolating a portion of the small intestine of a living animal, obtained an albuminous secretion which he found had no action upon starch, and with this observation Funke agrees. On the other hand, Masloff (*Unters. Physiolog. Inst. Heidelberg* [2], 1879, p. 290), Frerichs, and Busch (*Virchow's Archiv.*, xiv., p. 140) state that the small intestine has the power of transforming starch.

When commencing to investigate the hydrolytic action of the small intestine of the pig, we made use of an aqueous infusion of the tissue, made by acting upon one part of the well-washed and finely-minced intestine with five parts of water for from ten to fifteen hours.

Such an aqueous extract was prepared from three different portions of the intestine.

(1.) A portion of the *duodenum* immediately below the glands of Brunner.

(2.) The *agminated Peyer's glands* (Peyer's patches) cut from the jejunum.

(3.) Portions of the *jejunum* and *ileum* not containing any of the agminated Peyer's glands.

20 c.c. of the clear filtered infusion made with each of the above portions of intestine were added to 100 c.c. of a cane-sugar solution containing 4·557 grms. of sugar per 100 c.c. On digesting for three hours at 40° C., and allowing subsequently to stand in the cold for twenty-four hours, scarcely a trace of inversion was found to have taken place.

The action of equal quantites of the various infusions upon starch-paste was scarcely more marked; about 3 grms. of starch, in the form of starch paste, being employed in each case, at a temperature of 40—45° C. After digestion for sixty minutes, none of the samples of starch-paste showed any signs of limpidity. After sixteen hours, No. 1 was found limpid, but contained only soluble starch; No. 2 was perfectly limpid, and contained a little erythrodextrin; whilst No. 3 was absolutely unacted upon, the gelatinisation being still as perfect as at the outset of the experiment.

The pig, from which was derived the intestine used in the above experiments, had been killed after fasting for thirty-six hours. It occurred to us that the absence of any well-marked amylolytic action might be due to this fact, and that a different result would probably be obtained by infusing an intestine in which the various glands had been more recently active. In order to test this, an animal was killed about two hours after administering a liberal allowance of

barley-meal. In this case the aqueous extract of the small intestine possessed a somewhat greater action upon starch than in the previous experiment, but the transforming power was still very feeble, more than two hours being required for the production of limpidity in the starch-paste containing the most active of the three portions of the intestine, which was in this, as in the former case, the region of the jejunum and ileum containing the Peyer's patches.

It is possible, as was first shown by Berthelot, to obtain a clear aqueous infusion of ordinary yeast, which is capable of exercising a very decided invertive action upon cane-sugar. The action of this aqueous infusion is, however, feeble when compared with the inversion produced by actual contact of the yeast-cells themselves.

Reasoning from this fact, it seemed to us probable that, in the case of the intestine, far more pronounced hydrolytic results might be expected from acting with the tissue itself, than from merely using its aqueous infusion. This was found to be case.

In the following experiments the different portions of the small intestine, after thorough and prolonged washing, were dried rapidly in a current of air at 35° C., and were divided into very fine shreds, which were immersed directly in the solutions under examination. The intestine was taken from a pig of eight months old, killed during the period of digestion.

The solution of cane-sugar employed contained 3·020 grms. of sugar per 100 c.c.

To every 100 c.c. of this solution were added 5 grms. of the finely divided dry intestine. Temperature of digestion, 40° C.

All the determinations were made by the optical method.

Comparative Action of the different portions of the Small Intestine of the Pig upon Cane-Sugar.

Portion of the small Intestine.	Percentage of Cane-Sugar Inverted. After 1½ hrs. at 40°.	After 3½ hrs. at 40°.	After 16 hrs. in the Cold.	After further digesti'n for 5 hrs. at 45°.
(1) Duodenum immediately below the pylorus, containing Brunner's glands ..	No action	No action	No action	13·0
(2) Duodenum below the glands of Brunner ..	No action	No action	10·9	13·0
(3) Jejunum, not including any of Peyer's patches	—	14·0	19·5	25·1
(4) Ileum	—	14·0	19·5	25·1
(5) Agminated glands of Peyer (Peyer's patches), cut from the jejunum	9·2	18·4	24·6	26·7

Action of Various Portions of the Small Intestine upon Starch.

The action of the *tissue* of the small intestine upon starch-paste, as upon cane-sugar, is decidedly more energetic than that of its aqueous infusion. Limpidity of the starch-paste is, however, not rapidly brought about, and when produced the resulting soluble starch is very stable, and resists any sensible hydrolysation for a considerable time.

Strictly comparative experiments upon the amylolytic power of the various parts of the intestine were made in the following manner:—30 grms. of potato-starch were gelatinised with 1000 c.c. of water, and 1 c.c. of malt-extract was added to the resulting starch-paste after cooling to 60° C. The moment limpidity was produced, the further action of this trace of malt-extract was arrested by boiling. The liquid, filtered perfectly bright on cooling, and containing, besides soluble starch, only a trace of erythrodextrin and maltose was analysed; its specific gravity, optical activity, and cupric-oxide reducing power being determined. The solution was divided into portions measuring 100 c.c., into each of which were immersed 5 grms. of the dried and finely-divided intestine. The various experimental liquids were digested under exactly similar conditions, in the water-bath at 40° C.

The portions of the intestine taken were as follows, the animal from which they were derived being a young pig, killed during active digestion of starchy food:—

1. A portion of the duodenum taken immediately below the pylorus, and containing numerous Brunner's glands, which were very apparent in this case, owing to active digestion being in progress at the time of the animal's death.
2. Lower portion of the duodenum, not containing any Brunner's glands.
3. Agminated Peyer's glands, taken from the jejunum.
4. Portions of the jejunum, not containing any Peyer's patches.
5. Portions of the ileum, taken at the distance of a few inches from the ileo-cæcal valve.

The solutions gave the following iodine reactions, the dilute iodine solution being slowly added in each case up to an excess, thus ensuring the detection of any erythrodextrin:—

After digestion for fifteen minutes—all deep blue—no production of erythrodextrin.

After thirty minutes—a very slight production of erythrodextrin in all.

After forty-five minutes—all gave a violet reaction. From the larger amount of iodine solution requisite to produce a permanent colouration in No. 3, it was evident that the hydrolytic action was proceeding more rapidly in this than in any of the other solutions.

After three and a half hours—Nos. 1 and 2—deep violet reaction. No. 3 contained only a trace of unconverted soluble starch, and no erythrodextrin.

Nos. 4 and 5, violet reaction, but much lighter in tint than Nos. 1 and 2.

After the digestion for three and a half hours at 40°, and lying in the cold for sixteen hours longer, the various liquids were fully analysed. The corrected results are here given:—

Portion of the Intestine.	3½ hours at 40°.	16 hours in the cold.	
	$[\alpha]j_{3\cdot86}$.	$[\alpha]j_{3\cdot86}$.	$\kappa_{3\cdot86}$.
(1) Duodenum, with Brunner's glands	179·8°	149·3°	41·7
(2) Lower part of duodenum ..	163·4	140·7	47·8
(3) Peyer's patches..	148·3	122·3	63·3
(4) Jejunum	159·7	133·0	53·0
(5) Ileum	157·2	134·9	50·6

Upon calculating the composition of the transformation products from the above numbers, a very remarkable fact was brought to light. *Maltose* was present in only one case, that of No. 3, the whole of the cupric-oxide reducing body consisting in the other cases of *dextrose*. The percentage composition of the products is here given.

(1) Dextrose	41·7	$[\alpha]j_{3\cdot86}$.	$\kappa_{3\cdot86}$.	$[\alpha]j_{3\cdot86}$. $\kappa_{3\cdot86}$.
Soluble starch and dextrin ..	58·3	150·3°	41·7	149·3 41·7
	100·0	Calculated.		Found.
(2) Dextrose	47·8	$[\alpha]j_{3\cdot86}$.	$\kappa_{3\cdot86}$.	$[\alpha]j_{3\cdot86}$. $\kappa_{3\cdot86}$.
Soluble starch and dextrin ..	52·2	140·7°	47·8	140·7° 47·8
	100·0	Calculated.		Found.

(3) Maltose	16·6	$[\alpha]_{j3·86}$.	$\kappa_{3·86}$.	$[\alpha]_{j3·86}$.	$\kappa_{3·86}$.
Dextrose	53·1	122·0°	63·3	122·3	63·3
Dextrin	30·3	Calculated.		Found.	
	100·0				
(4) Dextrose	53·0	$[\alpha]_{j·386}$.	$\kappa_{3·86}$.	$[\alpha]_{j3·86}$.	$\bar{\kappa}_{3·86}$.
Soluble starch and dextrin..	47·0	132·6°	53·0	133·0°	53·0
	100·0	Calculated.		Found.	
(5) Dextrose	50·6	$[\alpha]_{j3·86}$.	$\bar{\kappa}_{3·86}$.	$[\alpha]_{j3·86}$.	$\kappa_{3·86}$.
Soluble starch and dextrin ..	49·4	136·3°	50·6	134·9°	50·6
	100·0	Calculated.		Found.	

The question now arises—has the dextrose obtained in these experiments passed previously through the stage of maltose, or has it been derived more directly from the starch?

Direct evidence, as well as that furnished by analogy, points strongly to the former proposition being the correct one. We have seen, in four out of five of the experiments, that the soluble starch resisted very persistently the hydrolytic action of the ferment. Where this resistance to transformation was least strongly marked, as in the experiment with the Peyer's glands, a little maltose was found.

The conclusion seemed a fair one that we had here to deal with a remarkable hydrolysing agent, differing, in its relative action upon starch and starch-products, from that of any other known ferment of its class; an agent which is in fact capable of hydrolysing *maltose* with greater ease than *soluble starch*.

On further experiment this surmise proved correct.

All portions of the small intestine exert at 40° a rapid hydrolytic action upon maltose; an action, however, which varies in intensity in different parts of the intestine, and is far more energetic than that of a similar portion of the intestine upon starch-paste, soluble starch, the higher dextrins, and even cane-sugar itself.

After thoroughly washing the small intestine of a pig, the portions of the jejunum containing the agminated Peyer's glands were cut out, rapidly dried at 35°, and cut into fine shreds, 5 grms. of which were immersed in 100 c.c. of a solution containing 3·107 grms. of pure maltose.

The mixture was digested at 40° for sixteen hours, and at the end of that time it was found that *the maltose had been entirely converted into a dextrose* which possessed the same specific rotatory power and cupric-oxide reducing power as ordinary dextro-glucose, with which it was doubtless identical.

All portions of the small intestine exert, *cæteris paribus*, a much more rapid and complete action upon maltose than upon cane-sugar, and the hydrolytic effect of the agminated Peyer's glands upon either of these carbohydrates is far greater than that of any other portion of the small intestine, either for equal weights or for equal areas of the tissue.

We have satisfied ourselves of the truth of these statements by numerous experiments.

The following results exhibit the relative action upon maltose and cane-sugar of (1) the agminated Peyer's glands of the jejunum, and (2) of the adjoining portions of the jejunum containing, besides the glands of Lieberkühn, only solitary Peyer's glands. The experiments were conducted under exactly similar conditions, 5 grms. of the dried and finely-divided intestine acting in each case upon 3 grms. of the carbohydrate dissolved in 100 c.c. of water.

1.—Action of Agminated Peyer's Glands of the Jejunum upon Cane-sugar and Maltose.

	Percentage of Carbohydrate Hydrolysed.			
	1½ hours at 40°.	3½ hours at 40°.	After 16 hours in the cold.	5 hours more at 45°.
Cane-sugar ..	9·3	18·4	24·6	26·7
Maltose ..	15·4	33·9	52·2	74·3

2.—Action of the Jejunum, without Agminated Peyer's Glands, upon Cane-sugar and Maltose.

	Percentage of Carbohydrate Hydrolysed.			
	1½ hours at 40°.	3½ hours at 40°.	After 16 hours in the cold.	5 hours more at 45°.
Cane-sugar ..	10·9	13·6	21·7	24·4
Maltose ..	4·2	26·6	38·6	57·9

These experiments, in conjunction with those upon cane-sugar previously described, prove that the activity of the small intestine upon saccharose is slow and incomplete, when compared with its power of converting maltose into dextrose; and also that, whilst the conversion of maltose into dextrose under the action of the intestine ferment is as continuous and uninterrupted a process as is its conversion by dilute sulphuric acid, the invertive action upon cane-sugar is decidedly limited, the action being either arrested or proceeding with extreme slowness, when 25 per cent. of the total quantity of cane-sugar has been inverted. The reason for this limited invertive action is by no means clear, and the subject requires further investigation.

Claude Bernard, who first demonstrated the existence in the small intestine of a soluble ferment capable of inverting cane-sugar, considered that in this property resided one of the most important functions of the *succus entericus*. By injecting a solution of cane-sugar into the veins and cellular tissue of animals he demonstrated that this carbohydrate, after traversing the system, is eliminated weight for weight in the urine, without undergoing any modification or assimilation. In order that cane-sugar shall be assimilated by the animal or vegetable economy, it must first be *inverted*. The seat of the invertive action is in the small intestine itself.

If this function of the small intestine has the importance attributed to it by Bernard, it is in the highest degree probable that the relatively far more active maltose-hydrating ferment, coexisting with the invertive ferment, must possess some considerable physiological value.

It must be remembered that, under natural conditions, the amount of cane-sugar which an animal is called upon at any given time to assimilate is very small when compared with the amount of products derived directly from starch.

We cannot consider, under these circumstances, that so well-marked and striking a function of the small intestine as that of converting maltose into dextrose can be useless to the animal economy. The most probable explanation is that maltose is incapable of assimilation in its unaltered state, but has first to be broken down to the smaller moleculed dextrose, just as cane-sugar, prior to assimilation, is converted into the chemically less complex dextrose and levulose. This is rendered the more probable from the known similarity of composition of maltose and cane-sugar, both bodies belonging to the class of sugars represented by the formula $C_{12}H_{22}O_{11}$.

Whether maltose is capable, under any circumstances, of being directly assimilated is a question, the solution of which we must leave in the hands of experimental physiologists. Probably a series of carefully conducted injection experiments, similar to those made by Bernard with cane-sugar, would yield the desired information. It is true that the estimation of maltose in urine would be attended with greater difficulties than the estimation of cane-sugar, but these difficulties are by no means insurmountable.

It will be remembered that the action of artificial pancreatic juice upon gelatinised starch is very rapid, the transformation products in a short time containing 80 per cent of maltose, which is but very slowly and partially converted into dextrose by a continuance of the reaction. The active agent of the small intestine, on the other hand, whilst exerting but little action upon gelatinised or soluble starch, converts with great readiness maltose into dextrose. Thus we see that in the transition from colloidal starch

to highly diffusible dextrose, the hydrolytic actions of the pancreas and small intestine *are mutually dependent and complementary to each other*, neither one set of actions alone being sufficient.

The small intestine does not contain a very active *amylolytic* ferment, because it is seldom or never called upon to act upon unaltered starch, the first portion of the work being completed by the pancreatic secretion. Brücke (*Wien. Akad. Ber.*, 65 (3), 126), when experimenting upon dogs fed with amylaceous food, found that the soluble starch and erythrodextrin which were produced in the stomach at once disappeared on passing the pylorus, under the rapid action of the pancreatic juice.

We have now to consider more fully the part played by the three different sets of glands of the small intestine in bringing about the hydrolytic effects which we have described. These glands are known as—(1) the glands of Brunner; (2) the glands or follicles of Lieberkühn; and (3) the glands of Peyer.

Brunner's glands occur only in the duodenum. They are most numerous immediately below the pylorus, and resemble closely in structure the salivary glands, or minute portions of the pancreas. When a portion of the duodenum containing these glands is macerated in water, the liquid becomes extremely viscous, owing to the extraction of the special glandular secretion. This effect is best observed by taking the duodenum of an animal which has been killed during digestion. The viscid secretion, resembling in appearance submaxillary or sublingual saliva, has but a very slight amylolytic action. The portion of the duodenum containing the glands has only a slight invertive action upon cane-sugar, but a somewhat more decided hydrolytic action upon maltose.

The glands or follicles of Lieberkühn consist of tubular depressions in the mucous membrane of the intestine, and are generally supposed to secrete the *succus intericus*, to which, however, the Brunner's glands must also largely contribute. Since Lieberkühn's follicles are pretty evenly distributed throughout the whole of the small intestine, and the hydrolytic effect of equal areas of the intestine varies very much in different parts, it is evident that these glands play no very important part either in the inversion of cane-sugar or in the still more active hydration of maltose to dextrose.

We believe that the variable hydrolytic action of the different regions of the small intestine is mainly, if not entirely, due to the relative frequency of the glands of Peyer. The solitary Peyer's glands occur most scantily in the upper portion of the duodenum, and here the hydrolytic effect is by far the least. As the solitary glands increase in number the action of the intestine becomes more strongly marked, and finally the regions of the jejunum and ileum containing the agminated glands, or Peyer's patches, are the portions of the intestine which exert the most pronounced hydrolytic effect upon maltose, cane-sugar, and starch. These glands consist of small ovoid masses of adenoid tissue, embedded in the mucous membrane, and enclosing vast numbers of leucocytes. The glands are in intimate relation both with the vascular and lymphatic systems, each follicle being penetrated by blood-vessels, and surrounded by lymph sinuses which are in connection with the lacteals of the villi.

The function of the Peyer's glands is by no means established. The opinion held by physiologists up to a few years ago that they discharge, by occasional rupture an intermittent secretion into the intestine, appears now to be abandoned in favour of the view that they are instrumental in absorbing material from the blood and chyle, which they elaborate and again transmit, in a modified form, in part to the portal blood, and in part to the lacteal system.

The property which the glands undoubtedly possess of hydrolysing maltose to dextrose, and of so rendering the starch products of the pancreatic digestion more fitted for nutrition, is probably one of these special functions of elaboration.

Our work on these matters has been necessarily restricted to the chemical side of the subject, and we must now, lest we should incur the charge of overstepping our *mêtier*, leave further observations in the hands of physiologists.

The following are the main points which we consider have been established by our experiments:—

(1.) The action of artificial pancreatic juice upon starch-paste or soluble starch at 40° C. is, in the earliest stages of the reaction, similar to that of unheated malt-extract acting at 60° C. and under, the composition of the starch products becoming comparatively stationary when 80·8 per cent of maltose has been produced.

(2.) Both malt diastase and pancreatic diastase are capable of hydrolysing the lowest achroodextrin to maltose.

(3.) Pancreatic diastase is capable, by long continued action at 40°, of slowly but sensibly converting maltose into dextrose, a change which malt diastase is incapable of effecting even under the most favourable circumstances.

(4.) Neither artificial pancreatic juice, nor the tissue of the gland itself contains any ferment which is capable of inverting cane-sugar.

(5.) The small intestine is capable of hydrolysing maltose, of inverting cane-sugar, and of acting feebly as an amylolytic ferment.

(6.) The action of the tissue of the small intestine in bringing about these changes is far greater than that of its mere aqueous infusion, and differs materially in different regions of the intestine.

(7.) The variability of the hydrolytic action of different portions of the small intestine is independent of the relative frequency either of the glands of Lieberkühn, or of those of Brunner, but appears to be correlative with the distribution of Peyer's glands.

(8.) In the transition from colloidal starch to readily diffusible and easily assimilated dextrose, the actions of the pancreas and of the Peyer's glands are mutually dependent and complementary.

The pancreas readily breaks down the starch to maltose, but is capable only of a very slow conversion of the resulting maltose to dextrose. The Peyer's glands, on the other hand, whilst almost powerless upon starch itself, take up the work at a point where the pancreatic juice almost ceases to act, and so complete the conversion of starch into dextrose.

ON THE

PRESENCE OF RED OXIDE OF MERCURY IN OLD SAMPLES OF GREY POWDER.

By DAVID LINDO.

Hydrargyrum cum creta, recently prepared, is no doubt justly considered the mildest of mercurial preparations. That it may become poisonous by long keeping, through absorption of oxygen and consequent conversion of the metal into mercuric oxide, is a fact worth noting, and which ought to be pretty generally known; yet, I find no allusion made to it in works in which we should certainly expect to find it mentioned.

In September, 1878, I was asked to examine a sample of grey powder (or rather what was once grey powder), strongly suspected of having caused symptoms of irritant poisoning which exhibited themselves in children who had taken some of it; and of having caused salivation in the case of an adult—doses not specified.

The quantity brought to me weighed about 509 grms. It was contained in a glass bottle, closed with a fairly fitting cork, covered on the under surface and sides with white kid. The bottle was about three-fourths full, and was alleged to be the original package in which the drug had been imported from England in 1862. It had not been excluded from light, and for some time previous had been left neglected on a shelf. The mass possessed a decided

reddish colour throughout, and I could detect no globules of mercury in it by the most careful scrutiny with a powerful lens. Pure cold dilute HCl dissolved the substance almost entirely, and solution of stannous chloride produced a copious precipitate when added to the filtered fluid. Further examination being unnecessary, in order to pronounce the sample unfit for use, it was put aside for more complete investigation at some future time.

I have recently estimated the amount of mercuric oxide in this sample, as well as the total mercury. At the same time, I have examined ten other samples of grey powder; one prepared by myself in September, 1878, and the remaining nine collected from different dispensaries in the Island. The sample prepared by myself, has been kept from the light in a glass stoppered bottle, which it nearly fills. The bottle has been rarely opened. It now gives up only 0·14 of 1 per cent of metal to cold pure dilute HCl,* equal to about 0·15 of a per cent mercuric oxide.

Of the other nine samples, three were found to contain a large proportion of the metal in the form of mercuric oxide, and two sufficient of this impurity to render them unsafe. The results of the analyses are given below. The remaining four samples may be considered mild preparations, since they contain mere traces of mercuric oxide, if any. No two of these, however, exhibited the same shade of colour, and would, no doubt, be found to vary to the same extent in activity.

The darkest slate among them yielded only 0·18 of a per cent of metal to cold dilute HCl.

	Mercury in form Soluble in Cold Dilute HCl, per cent.	=	Mercuric Oxide, per cent.	Total Mercury, per cent.
No. 1. Supposed to be about 18 years old..	35·26	=	38·08	36·19
No. 2. Age not known	23·67	=	25·56	32·65
No. 3. Said to be 7 to 8 years old	15·79	=	17·05	31·75
No. 4. Said to be 4 to 5 years old	17·05	=	18·41	33·37
No. 5. Age not known	7·40	=	7·99	30·22
No. 6. Age not known	5·33	=	5·75	31·45

No. 1 is the sample first alluded to. As already stated, no globules of mercury were found in it when first examined. I have since failed to detect any, even in the residue left on dissolving it in dilute HCl. Globules of metal were found in all the others. Allowing for increase of weight due to absorption of oxygen, these samples would originally have contained mercury per cent as follows.—

No. 1.	37·24
No. 2.	33·28
No. 3.	32·16
No. 4.	33·83
No. 5.	30·40
No. 6.	31·58

No. 1 must therefore have been compounded according to the formula, 3 of mercury to 5 of chalk, which requires 37·5 per cent of metal, and the others (though most of them not accurately) according to the more usual formula, 1 of mercury to 2 of chalk. The colour of the red oxide of mercury was very apparent in Nos. 1 and 2, and ought to have attracted attention, yet these samples were being dispensed. The others were not sufficiently tinged by the acquired impurity to excite suspicion by mere inspection of there being anything wrong.

The following passages occur in Neligan:—

"According to the recent investigations of many celebrated chemists, grey powder appears to consist of metallic mercury in a state of minute division, a very small proportion of mercurous oxide, and carbonate of lime combined mechanically."

Under Characters and Tests.—"The solution formed with hydrochloric acid is not precipitated by the addition of chloride of tin."

Under Adulterations.—"I have always found this a very pure preparation; the pharmacopœial test with chloride of tin is directed against mercuric oxide, a possible impurity, and which, were it present, would be a most serious one."

I have never met with a sample of grey powder, however recently prepared, that would stand this test perfectly. Though the experiment may be performed at the ordinary temperature, and the acid employed be pure and dilute, a *small* quantity of metal is always found in solution. Whether this is owing to the presence of mercuric oxide produced during the manufacture, or to the conversion of a small portion of the unstable mercurous oxide into mercuric oxide and metal during solution, it is difficult to determine.

In connection with this enquiry the question is of no practical importance, as I have found powders of a dark slate colour which evidently contained notable quantities of mercurous oxide yield mere traces of metal to the acid under the conditions stated.

The conversion of the metal into the higher oxide would be likely to take place more rapidly in a warm moist climate such as this is than in one where a lower temperature and drier atmosphere prevails. I can hardly suppose light to be an indispensable agent in bringing about the change, since it is difficult on that supposition to account for its pervading the entire mass, which was the case with the samples examined by me. I cannot vouch for the accuracy of the statements made respecting the age of these samples. I believe most of them were imported from England. No. 4 I am inclined to think much older than was alleged.

My object in publishing these analyses has been to show that poisonous samples of this preparation may be met with in dispensaries, without taking particular trouble to hunt them up; it remains for medical men to consider whether, under these circumstances, it would not be better to abandon its use, except in cases where they can personally vouch for its freedom from such deleterious impurity.

Falmouth, Jamaica,
June 25, 1880.

* The HCl employed in these analyses, besides being otherwise a very pure sample, was free from any trace of uncombined chlorine.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

General Meeting, March 23, 1880.

J. P. Joule, D.C.L., LL.D., F.R.S., &c., President, in the Chair.

Dr. Lloyd Roberts, of Kersal Towers, Higher Broughton, was elected an Ordinary Member of the Society.

Ordinary Meeting, March 23, 1880.

J. P. Joule, D.C.L., LL.D., F.R.S., &c., President, in the Chair.

"*On the History of the Word 'Chemistry' or 'Chemia,*' by Dr. R. Angus Smith, F.R.S., &c.

The author said that he had been led to a renewed consideration of the meaning of the word chemistry because of papers read lately on the subject by Prof. Schorlemmer, F.R.S., in Manchester, and Mr. Mactear, in Glasgow, a very brief abstract of the latter being seen. He had always been inclined to agree with Olaus Borrichius in his reference to Egypt for the word chemia and the chemical arts, as well as the early attempts at a science, and he was especially inclined to do so on reading of the few Greek manuscripts that have been published or described by sufficient extracts being given. The eyes of the writers were

evidently much turned to the land of Chemi, whilst Isis and Osiris were favourites. For many years he had occasionally tried to interest young Greek scholars in the subject, and he had hoped that when Dr. Kopp began his description in his very learned work the "Beiträge zur Geschichte der Chemie" that the examinations would have been exhaustive; but that author was not inclined to go further at the time.

If Formicus used the word chemia in the second, third, or fourth century, and if chemistry were meant, we have a good starting-point; but Formicus was an astrologer, and he gives no definition.

The tract by "Democritus" speaks of several chemical subjects, and he is said to have treated of metals and purple dyeing, having learnt Egyptian and other Eastern wisdom. Dr. Kopp considers that he may be referred to the fourth century. No criticism of any point of Kopp's enquiries was proposed; it was intended to begin where he had ended his enquiries, and to go into earlier times.

The old belief that chemistry has something to do with the soil of Egypt was not considered just. Brugsch says that Egypt is called black in contradistinction to the Desert, which is called red in hieroglyphic inscriptions. But the soil is not really black, and even if it were so chemistry can have no direct relation to it. Still an art might receive the name of the country it came from, as Japan gives us japanning, &c. But so much came from Egypt to the West that we have little reason to suppose that such an obscure subject as chemistry would be the only one to take up the name of such an illustrious country and carry it to the West, whilst only those outside who foresaw the greatness of the science would give it a great name. The Egyptians themselves would scarcely do so. Why should they choose this as peculiarly characteristic of their country?

Dr. Angus Smith came to the idea that the word חֵמָה (Hema or Khema), meaning heat in Hebrew, was much more likely to be the origin of the name *chemia* than any hitherto fixed upon, and hoped by the later researches in Egypt and Assyria to have some light thrown upon it. Prof. Theodores, of Owens College, being asked, gave information which confirmed him in the belief, and also showed that the word was not an Arabic one. "If *Kimia* be an Arabic word the attempt to graft it on hot or black is futile," and he quotes Bochart's proposal to derive it from *Kama*, to conceal, but wisely sets such aside. To quote one of his letters again—"חמם (cognate in character to יהם) means to be hot; from it are derived the forms "Hammah, "heat," also sun, "the receptacle of heat." Another noun is Hema, "fiery anger." This latter form occurs in Deuteronomy, xxxii., 24, in connection with the names of snakes or some such animals." This word is, according to Prof. Theodores, incorrectly translated "poison." It would appear to be *heat*, as in *hot with rage*. The author did not know how far Semitic scholars would allow the next stage, which is to connect this with חֵמָה, which certainly softens the first letter, giving us the meaning of *noise and excitement as by intoxicating drink*.

On enquiry of Dr. Birch how such a word could be connected with the Egyptian and Assyrian, he says, "The word for heat is *Hhamamu* or *Khamamu*." Then he gives *qam*, Egypt, or the black land, *qam* meaning in Egyptian *black*.

Having obtained the first idea, *heat*, it was impossible to avoid going thus far, but there was a difficulty, namely, in the connecting-links between Egyptian and Semitic. Still it is allowed that there is frequent connection, and this word links itself with the Hebrew both towards Egypt and Assyria. It was too early to stop here, because we have the province of Egypt, Chem, which would seem to have been the kernel of the Egyptian nationality, the nation keeping, as it expanded, the original name. The metropolitan name of Chem is Chemmis, although Thebes overshadowed it. In Brugsch's "Egypt from the Monuments"* we learn that the district was especially under the God Chem, who was the divine representative of heat as emanating from the sun and producing life in all nature—not the sun as the Glorious Apollo, but the sun, we might say in modern phrase, as an actinic agent. Chem was called Pan by Greeks and Romans from some inferior characteristics. Pan, like Chem, had his high and his undignified position. Chem was "the Lord of Coptos," to which place there was a road from the Red Sea, through the very hot district of *Hammamat* (still from heat), where stones for the temples were obtained, and where attention was paid to the discovery of gold and silver, and where Chem was held as "the Master of the tribes which inhabit the valley," and "the Lord Protector of the mountain."† Many complaints were made of the heat of this valley, where wells were dug in the time of Rameses the Second, because others much older had been closed up. It was a burnt land, and it still preserves its ancient character. It is the earliest place where we know metals to have been studied. On the west of the Nile and opposite was Tini, famous for purple dye, another branch of chemistry. Tini, or *Thinis*, or *This*, was the place where the earliest king *Menes* sprang from. In *Chem* we are in the land of Heat, where the God of Heat was worshipped, where metals were worked, and where other chemical processes were employed, and from which the first chemist, whose writings are clearly on chemical subjects, and whose drawings are clearly of chemical apparatus, sprang,—viz., Zosimus the Panopolite, or Zosimus of Chemmis, for this is the proper name of his city. The translation of Chem into Pan has been misleading, and still more of Chemmis into Panopolis.

We thus see that chemistry has received its name from no trifling accident, but from that great natural agent which has made the science, and the character of which we are continually learning.

Prof. Theodores had quoted for the author Bunsen's "Die Stellun Aegypten's in der Weltgeschichte," v. 5, s. 2, where he says, "'Hem' or 'hêm,' Sieden glühen (*i.e.*, to boil, to glow with heat) = Hebrew, ham," and the next part of the quotation must be kept in view—"h is related to S. The Egyptian Sôm has the same value, and with this the Teutonic Sommer. Summer has some connection through Sun, Sonne." This helps us to bridge over some of the ground to be seen.

Sayce's Assyrian Vocabulary was then consulted in order to see if an Assyrian or Accadian origin could be found for the word. No Accadian word of the kind was found. We are then guided to Semitic Assyrian, which has—

Samsu, the sun.
Samu, the heavens.
Samas, the sun-god.
Khamamu, and Khammu, } heat.
Khamsa, fire.
Khamdu, light.

The word then had full force in the East beyond Egypt.

The examination of metals, dyeing, colour-making, and distilling seem decidedly to be referable to Egypt. Distillation leads to alcohol readily, when juices of plants containing sugar are used, and still more so when sugar is added.

In Egypt there were drinks of great potency, but the fullest idea seems to have grown in this direction in Asia, where the Kh or Ch was much softened into h, and converted into S. This is done by laws not to be examined here, but received from those who have studied the tongues of the regions under view (see the quotation from Bunsen).

The study of intoxicating liquors was carried out more fully in Asia, where mysticism was most prevalent. It is

* "A History of Egypt under the Pharaohs, derived entirely from the Monuments," by Brugsch-Bey. Murray, 1879.
† From Brugsch-Bey.

probable that the love of the spiritual, the unseen, and the immortal, was among some tribes at an early period connected with intoxicating substances. This itself is a great field of historic enquiry full of interest.

We have seen how *hama* is connected with Sôm, and if we go far East we find the great Asiatic drink Soma used by the inferior gods to strengthen them in their fight with demons. Soma is the Sanskrit word for this drink, but there are many Semitic words the same in Sanskrit, and this evidently has the same root, which is seen in Egypt moving towards metals and general chemistry: it had more force in the far East in connection with the mystic drink, although the idea may have arisen in Egypt. The vessel into which the drink flowed, the receiver, was called *kama* ("Indo-germanische Chrestomathie," by Ebel, Leskien, Joh. Schmidt, and Aug. Schleicher). In old Bactrian the word appears as *haoma*, whilst in Russian we find it returned, in all probability, as *koumiss*, to more western lands. We have yet to learn fully the medical effects of the *asclepias acida*, or moon plant, from which the Soma was made. Ordinary alcoholic liquids made by fermentation are notwithstanding much condemned in the Institutes of Menu.

The connection of the earliest thoughts of civilisation and the later is remarkably seen in the history of this word. The hope of happiness from intoxicating liquids is evidently the direction which theory took in the minds of some searchers for truth, and constant deception seems not to have cured men entirely. We have removed the intense faith in the delusion, and retained the name of the substance, *i.e.*, *aqua vitæ*, *eau de vie*, *uisge beatha*, all meaning water of life. The Germans simplified the word by calling it *burnt wine* (Brenntwein) or brandy, and we have cut down the latter and Celtic form into whiskey. This history of the theory is believed to be correct, although quite apart from the derivation of the word chemistry. The connection of chemistry with *moist* or *dry* was considered as too slight to form a basis for an opinion, and the superstition concerning a plant that made gold was simply held to have no solid place in the history. The belief that the word *kem*, in Arabic, alluded to the fifth element, or *ether*, as one of the five existences spoken of in an important part of Indian philosophy, was rejected --but this abstract is already longer than usually allowed.

"*On the Electrical Resistance and its Relation to the Tensile Strain and other Mechanical Properties of Iron and Steel Wire*," by William H. Johnson, B.Sc.

It has long been known that there is a great variation in the tensile strain of various qualities of iron and steel wire, depending on the mode of manufacture and purity of the material used, and it occurred to the writer that it would be interesting to examine if this difference in quality was accompanied by a corresponding alteration in the electrical resistance.

If electricity is a mode of motion of the particles of matter, then it is only reasonable to suppose that anything which constrains this motion will increase the electric resistance, and *vice versa*. Thus an annealed wire should conduct electricity better than an *un*annealed, and a hardened and tempered steel wire, whose particles are in a state of tension, worse than a bright wire; also, from the analogy of copper wire, any increase of impurities in the iron would probably augment the electrical resistance. The following experiments will be found to confirm these views:—

A series of preliminary experiments were made, beginning with a pure iron, smelted and worked throughout with charcoal, and ending with a highly carbonised steel wire.

The apparatus used was a Wheatstone bridge, with divided metre scale and reflecting galvanometer of low resistance. All the wires except the piano steel were drawn in the same way to No. 18½, and then either hardened and tempered, or annealed and finished by drawing one hole to No. 20 = 0·038 inch. The length of wire tested electrically varied from 8 to 3 metres; care was taken to select such a length that the resistance was about 1 ohm, as then all four arms of the balance were equal. A thermometer was placed close to the wood drum on which the wire was coiled, and the temperature noted at the time of each experiment.

The circuit was first closed by pressing a button, and then connection with the galvanometer was made. By a suitable arrangement of keys the current was allowed to circulate through the wire such a short time that it could not sensibly increase its temperature.

The wire was tested for breaking-strain in an apparatus similar in principle to a steel-yard weighing machine; the weights could be added without any jar, and the elongation recorded at the moment of rupture. The length tested measured always 10 inches between the jaws of the machine.

The diameter was measured by a decimal gauge, manufactured by Elliott Bros., reading to 1-1000th inch.

The tortion tests were made by gripping a wire in two vices 8 inches apart, and turning one of them on to a suitable apparatus till the wire broke.

The results are given in Table A. Charcoal iron is here seen to have the least electrical resistance, or about one-half that of piano steel. We also notice a regular increase of resistance as the impurities augment. Charcoal iron is almost chemically pure, while dephosphorised iron, the next on the list, has some impurities which increase in ordinary iron wire. Again in the samples of steel, piano steel wire, which has the highest electrical resistance, contains two or three times as much carbon as mild steel, while steel wire samples 3*a* and 2*a* are intermediate in carbon as they are intermediate in electrical resistance.

Table A shows that the breaking-strain and electrical resistance increase together.

A series of eight sets of experiments were made on various specimens of charcoal iron wire to determine the effect of annealing on the electrical resistance, but without definite result, as the alteration caused by annealing appears to be so small that it is difficult to distinguish it from variations arising from change of temperature.

Annealing diminishes considerably the electrical resistance of puddled iron wire, and has a marked effect on steel, the exception in the case of sample 3 *a* being probably due to temperature.

The annealed samples were cut originally from the same piece as the bright, and the same was the case with the hardened and tempered, so they are identical in chemical composition.

As the electrical resistance of steel wire seemed from these experiments to increase very rapidly, the writer determined to investigate it more closely. A set of seven samples of cast steel wire were prepared, all of them manufactured in the same way, differing only in the amount of carbon and other impurities. These samples were drawn to No. 18½ and each coil divided, one-half being hardened and tempered, then drawn to No. 20 and tested; the other half of each coil was annealed and drawn one hole to No. 20, then tested in the bright state, and afterwards part was annealed and tested. The eighth sample was Bessemer steel, drawn and tempered in the same way as the others. The tempering was done in melted lead at a constant temperature.

The results are given in Table B.

The electrical resistances in this Table, as in A, are the mean of two or more experiments differing very little amongst themselves: the method of experiment and apparatus was the same as used before.

The figures denoting breaking-strain, elongation, and torsion, as in Table A, are the mean of two experiments in each case. These two experiments gave results sometimes the same, at others differing 4 to 6 per cent in the annealed samples, 3 per cent in the hardened and tempered, and 4 per cent in the bright wires, except in sample No. 6, where a difference of 20 per cent was observed.

TABLE A.

ELECTRICAL AND MECHANICAL TESTS OF VARIOUS QUALITIES OF IRON AND STEEL WIRES.

Quality.	Sample No.	Length.	Weight.	Resistance 1 Metre Gramme.	Temperature of Experiment.	Breaking-Strain per Sq. Inch.	Twists in Eight Inches.	Elongation per Cent.	Diameter
		M'ts.	Grms.	Ohms.	Degrees.	Lbs.			Inch.
Annealed Charcoal Iron	6*a*	8	47·403	0·7875	13·0	50,280	138·5	27·75	0·039
Bright ditto	7*a*	8	47·391	0·7852	13·5	105,840	57·0	2	0·038
Dephosphorised Iron, Annealed	—	5	28·000	0·8908	10·0	63,504	189·0	23	0·038
Annealed Iron	9*a*	6	35·040	1·0123	13·0	66,740	134·5	25·5	0·038
Bright ditto	8*a*	6	33·231	1·0696	11·5	112,896	49·5	0·75	0·038
Mild Steel, Annealed ..	5*a*	6	32·890	1·1140	12·5	70,268	207·0	19	0·038
Ditto do. Bright ..	4*a*	6	33·291	1·1270	15·5	98.784	46·0	1·25	0·038
Annealed Steel	3*a*	8	46·286	1·2520	15·0	95,256	149·0	16·25	0·038
Bright ditto	2*a*	3·50	20·081	1·2470	14·5	132,600	69·0	1·5	0·038
Hardened and Tempered ditto	1*a*	5·20	29·500	1·2832	13·5	134·244	96·0	1·5	0·038
Annealed Piano Steel ..	—	4	28 930	1·3422	10·25	127,840	152·0	9·5	0·043
Hardened and Tempered Steel (Piano) ..	—	5	35·230	1·4497	11·25	287,540	75·0	2·62	0·043

TABLE B.

		Electrical Resistance per Metre Gramme.						Breaking-Strain in lbs. per Square Inch.			Twists in 8 inches.			Elongation at Moment of Fracture.		
Quality.	Sample No.	Annealed.		Bright.		Hardened and Tempered.		Annealed.	Bright.	Hardened and Tempered.	Annealed.	Bright.	Hardened and Tempd.	Annealed	Bright.	Hardened and Tempd.
		Ohms.	T.	Ohms.	T.	Ohms.	T.									
Cast Steel	1	1·140	13°	1·157	13½°	1·225	13½°	109,335	166,785	208,330	63·0	16·0	23·0	19·50	1·50	1·75
,,	2	1·903	11¼°	1·913	11½°	1·980	11¼°	105,810	155,140	204,780	67 0	19·0	19·0	17·87	2·00	1·87
,,	3	1·560	10¾°	1·575	11°	1·641	10°	96,075	137,695	169,270	64·0	44·5	63·0	19·25	1·50	1·75
,,	4	1·519	11¾°	1·526	12°	1·597	12°	91,701	132,305	170,160	89·0	59·5	47·0	17·25	1·62	1·75
,,	5	1·450	11½°	1·465	12°	1·526	12°	90,493	135,785	167,015	95·0	77 0	64·5	18·50	1·75	1·75
,,	6	1·430	8¾°	1·444	10¾°	1·515	10½°	89,937	123,590	166,515	81·5	105·0	63·5	19·50	1·75	1·87
,,	7	1·417	9½°	1·437	11°	1·502	11°	88,174	130,549	158,110	76·5	37·0	49·5	19·12	1 87	1·50
,,	8	1·070	9½°	1·098	11°	1·158	10¼°	79,718	135,790	158,110	140·0	43·0	32·0	19·50	1·00	2·00
Total ..		12·489		12·615		13·144		751,243	1,117,539	1,402,290	676·0	40·1	361·5	150·49	13·79	14·24
Average..		1·561		1·577		1·643		93,905	139,692	175,286	84·5	50·1	45·2	18·81	1·72	1·78
Per cent..		100		101·03		105·25		100	148·76	186·66	187·0	110·93	100			

This probably accounts for the wide divergence of this sample.

These variations may seem large, but it must be remembered that there is an essential difference between an observation on electrical resistance and one on tensile strain. If we suppose the length L of wire under experiment divided into a great number of extremely short pieces, l_1, l_2, l_3, &c., each one would have a slightly different breaking-strain, b_1, b_2, b_3, &c., and electrical resistance, r_1, r_2, r_3, &c., depending on the physical structure of each length, l_1, l_2, l_3, &c. Now the observed electrical resistance R of the wire L is the sum of all resistances of the parts l_1, l_2, l_3, &c., or $R=\Sigma(r)$, while the observed breaking-strain is not the *mean*, but the *minimum* breaking-strain of all the pieces l_1, l_2, l_3, &c. It is an experimental fact, that the longer the piece of wire under experiment, the lower will be the breaking-strain.

Some of the results of the experiments are given in Table B. Here we see again that the electrical resistance and breaking-strain increase together in a pretty regular way, the variations observed probably being due partly to differences in temperature, but chiefly to the fact just explained, that in the electrical experiments we register a *mean*, while in the experiments on tensile strain we register a *minimum*, observation. This law must be applied with due care, and only where the samples have been drawn in the same way.

The mode of manufacture of the eight samples of steel leads one to believe that there is a regular increase of carbon and other impurities from No. 8 to No. 1. The writer hopes shortly to analyse these wires, as the resistance of some of the samples is most remarkable, being no less than three times that of pure iron.

No attempt has been made to reduce the electric observations by calculation to some fixed temperature, as it seemed improbable that samples with such varied resistances would increase in the same proportion as pure iron.

Table B shows us that annealing diminishes the electrical resistance of bright steel wire some 1 per cent, while hardening and tempering increases the resistance of annealed steel about 5 per cent. Now we may observe that the greatest increase of electrical resistance, viz., 8·1 per cent, and of breaking-strain resulting from hardening and tempering, is found in piano steel, thus clearly showing that any process like wire-drawing or tempering, which makes the particles of steel more rigid and difficult to separate, increases the electrical resistance.

The torsion tests vary a good deal among themselves, but it is interesting to observe, from Table B, that the mean breaking-strain of hardened and tempered steel is to that of the same steel annealed in the inverse ratio of the number of twists in 8 inches. The electrical resistance of the samples of steel is seen from Table B to be usually inversely proportional to the number of twists in 8 inches.

It is generally allowed that the heat conductivity of metals is nearly proportionate to their electric conductivity. If this relation between the thermal and electric con-

ductivity holds good for different qualities of iron and steel, then the electric resistance is an important factor of all iron and steel plates used in the construction of boilers, fire-boxes, &c. It is important that the plates exposed to the flame should conduct heat well, and one of the advantages claimed for steel over iron is that, as a thinner plate can be used, it allows more heat to pass than the thicker iron one.

Thus a ½-inch steel plate can replace a ⅝-inch iron plate; but our experiments lead us to believe that, as steel conducts electricity worse than iron, the thin steel plate may, after all, let less heat through in a given time than a thick iron one.

Suppose the iron plate has a resistance of 0·90 ohm per metre gramme, and the steel plate a resistance of 1·11 ohms, then a ⅝-inch iron plate will allow as much heat to pass per unit of area as a ½-inch steel plate. If the steel plate be more highly carbonised—say of Siemens-Martin steel—then the ½-inch steel plate will allow no more heat to pass per unit of area than an iron plate 3-16ths inch thicker. There is not space here to discuss this subject fully, but there is no doubt of its importance, and it is probable the time will soon come when our leading boiler-makers will electrically test their steel plates, perhaps by the induction balance, just as they now test them for ductility and tensile strain.

Microscopical and Natural History Section.

March 15, 1880.

C. Bailey, F.L.S., President of the Section, in the Chair.

Dr. Tatham, of Salford, described a new form of Stephenson's Binocular, which has been recently introduced by Messrs. Baker, of Holborn.

The microscope, being mainly intended as a working instrument, is of firm, rather than of elegant construction; the stage is remarkably large and substantial, and is so firmly mounted that it affords efficient support for the hands during the manipulation of an object under the microscope. The stand does not possess the usual axial joint; but inasmuch as that portion of the tubing which carries the eye-pieces is bent at almost a right angle with the perpendicular portion of the body which carries the objective, the axial inclination of the stand is unnecessary. The binocular prism is remarkably well ground and set, and under it objects of considerable thickness, such as injected specimens, stand out in relief, much in the same way as they appear under the Wenham's binocular. The instrument is capable of being used binocularly with high, equally well as with low powers; the prism acts as an erector, and when used in combination with a "combined two- and four-inch objective," recently invented by Zeiss, it forms a most useful dissecting microscope.

Dr. Tatham bore testimony to the great comfort he has experienced in the use of this form of binocular, and augured for it an extensive sale, more especially as the price of the binocular, stand complete, does not exceed seven or eight pounds.

CORRESPONDENCE.

ERRATUM.—DIAZO-COLOURS.

To the Editor of the Chemical News.

Sir,—Will you kindly insert an *erratum* in your next issue to the effect that the signature to my letter on "Diazo-Colours" is misprinted "R. Meldoda" instead of

R. Meldola.

August 3, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Bulletin de la Société Chimique de Paris.

No. 7, April 5, 1880.

Decomposition of Oxygenated Water in Presence of Alkalies, and the Derivatives of Barium Peroxide.—M. Berthelot.—Already noticed.

Analysis of the Waters of Bourboule.—E. Willm.—Already noticed.

Russian Chemical Society. Session, April 17/5, 1879.—MM. Jawein and Beilstein communicated a paper on the electrolytic determination of cadmium.

M. N. Lubavine described his researches on the nuclein of milk (see *Bulletin*, xxix., p. 213). The author considers that the phosphorus found in nuclein and casein does not occur in the state of a phosphate.

M. Flavitzky stated that lævo-rotatory terebenthen yields hydrated terebenthen under the influence not merely of nitric, but of sulphuric and hydrochloric acid.

M. P. Latschinoff pointed out the discrepancies between his results and those of M. Tappeiner on the oxidation of cholalic acid by means of permanganate and sulphuric acid.

The 5th part of Vol. xi. of the *Journal of the Russian Chemical Society* contains a memoir by M. Rudneff on the amines with tertiary radicles.

No. 8, April 20, 1880.

Action of Bromine upon Diphenyl-methane.—C. Friedel and M. Balsohn.—The authors have obtained bibromated and mono-bromated diphenyl-methane, the latter of which, if left for some days in contact with water at common temperatures, is completely transformed into benzhydrol.

Constitution of the Salts of Rosaniline and of Analogous Colouring-matters.—A. Rosenstiehl.—In this first memoir the author criticises the views of former writers, especially of MM. Emil and Otto Fischer.

Continuous Method of Preparing Acetic Ether.—J. A. Pabst.—The author introduces into a retort a cold mixture of 50 c.c. of sulphuric acid and the same measure of alcohol, and as soon as the mixture has arrived at the temperature of 140°, he allows to flow slowly into the retort a mixture of equal equivalents of alcohol and of glacial acetic acid. At first a little sulphuric acid distils over, and then there passes a liquid containing 85 per cent of acetic ether.

The Fatty Acids of Butter.—E. Wein.—According to the author butter contains the following fixed acids:—Palmitic, oleic, stearic, myristic, and arachitic, the two latter in small quantity; and the following volatile acids: normal caprylic, capric, normal caproic and butyric. Acetic and formic acids have also been found, but the propionic, valeric, œnanthylic, and pelargonic acids could not be detected.—*Sitzungsber. d. Phys. Med. Soc. Erlangen*, xi., p. 1644.

Moniteur Scientifique, Quesneville.

March, 1880.

Determination of Specific Heats at a Constant Volume in Simple and Compound Bodies.—G. Quesneville.—The author maintains that the method indicated by Clausius leads to results inaccurate, even for simple bodies, and much more so for complex compounds. He has therefore adopted another process, based on the knowledge of the constitution of bodies, which chemical syntheses enable us to foresee. He shows that the combinations of the non-metals among themselves, with the exception of hydrogen, are effected without the loss of

atomic heat. Those in which there occur more than two atoms of hydrogen are always attended with a loss of atomic heat, depending on the number of the atoms of this element, which take part in the formation of compounds capable of acting as true radicles. By introducing the single radicle CH_2, he calculates in all cases the specific heats of compounds, and shows that the numbers thus obtained agree with those given by observation, whilst on introducing the usual radicles of the atomists the numbers are always different.

Electricity in the Service of Life.—A summary of the modern applications of electricity, translated from a lecture given by Dr. Werner Siemens, delivered at a General Meeting of the German Congress of Naturalists and Physicians, held at Baden-Baden in October last.

Radiant Matter.—E. Ricklin.—An account of the recent investigations of Mr. Crookes.

History of Benzoyl Green and Malachite Green.—Otto Fischer.—From the *Berichte der Deutschen Chem. Gesellschaft.*

On Ultramarine.—Dr. Knapp.—An abstract from *Dingler's Journal.*

Beer, the Queen of Alcoholic Drinks.—M. Dubrunfaut.—This paper can scarcely be regarded as of a scientific nature.

Sessions of the Chemical Committee of the Industrial Society of Mulhouse.—M. E. Weiss ascribes the corrosion of steam boilers to the action of ozone, which he supposes to be generated by electric action, the result of steam violently impelled against the upper portion of the boiler.

The Process for the Manufacture of Sugar.—An account of a process patented by L. Faucheux.

Remarks on the Analysis of Mixed Tissues of Silk and Cotton, Wool and Cotton, &c.—J. Persoz.—The author recommends the following process:—Supposing a tissue is of silk and cotton, he takes three swatches, Nos. 1, 2, and 3, of arbitrary sizes, and weighs them at the same instant. Let their respective weights be a, b, c. No. 1 is preserved in its original state. The dye is removed as completely as possible by means of acid baths, and No. 2 after being pressed is set acid to be dried. No. 3, whilst still moist is treated with caustic soda or chloride of zinc, and the residue (cotton) is dried in the air along with Nos. 1 and 2. After the lapse of several hours two successive concordant weighings show that the fibres are in hygrometric equilibrium with the air of the laboratory, when the new weights, α, β, γ, of the swatches Nos. 1 and 2 and of the residue No. 3, are noted. These six data, a, b, c, α, β, γ, serve to show the results of the analysis. If we knew the successive weights of the swatch 3, first in its untouched state, then when stripped of dye, and lastly when reduced to a residue of cotton, all in the same atmospheric conditions, we should have all the elements necessary for the solution of the problem. But they are easy to calculate. Let us call these weights, supposed to be obtained at the end of the experiment, x, y, z. Then $x = c \cdot \frac{\alpha}{a}$, the original swatch; $y = c \cdot \frac{\beta}{b}$, the swatch stripped of dye, and $z = \gamma$, the residue of cotton. Hence we find the percentages of dye and dressing, TA, and of cotton, C.

$$TA = 100 \cdot \frac{a.b - a.\beta}{a.b}.$$

$$C = 100 \cdot \frac{a.\gamma}{a.c}.$$

The proportion of silk S is found as the difference. This method of operating renders it possible to take account of the variation which may take place in the hygrometric condition of the air during the interval between the first weighing and the last. If this variation $= 0$, then $\alpha = a$, and the above expressions are reduced to the form—

$$TA = 100 \cdot \frac{b - \beta}{b}, \text{ and } C = 100 \cdot \frac{\gamma}{c}.$$

So-called Spontaneous Decomposition of Hydrocyanic Acid.—Perfectly pure hydrocyanic acid may be preserved for an indefinite time without decomposition. The decomposition in question is due to the presence of a trace of ammonic hydrocyanate or of an alkaline cyanide.

New Process for the Preparation of Nitrous Ethers.—M. Armand Bertrand.—This process depends on the action of aqueous hydrochloric acid upon sodium nitrite in presence of an alcohol.

Verhandlungen des Vereins zur Beforderung des Gewerbfleisses. No. 3, March, 1880.

This number contains no chemical matter.

NOTES AND QUERIES.

Vanadium Ink.—Can any correspondent tell me where I can buy vanadium ink?—J. C.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1880-81 will commence on FRIDAY, OCTOBER 1st, 1880. Four entrance Scholarships, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Entries on or before September 20. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other hospital appointments are free. The resident appointments consist of Five House Physiciancies, Four House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the Metropolis.

MUNRO SCOTT, Warden.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

SPECIALITIES.

MANGANESE—Finest Crystallised, Lump, Ground, and Granulated of every quality, and PREPARED for *Chlorine, Glass, Steel, Ferro-Manganese, Pottery, Battery,* and EVERY PURPOSE.

BAUXITE—(Hydrate of Alumina) Of high percentage of Alumina and almost free from Iron. The CHEAPEST, BEST, and MOST PROFITABLE article from which to produce ALUM, ALUM CAKE, and SULPHATE OF ALUMINA, &c. [BRAND, "IRISH HILL BAUXITE."]

FLUOR-SPAR—Of the Very Finest Quality for Acid, Soda, Glass Flux, and all purposes.

BARYTES—(Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

CRYOLITE—Magnesite, Felspar, Arsenic, Phosphates, French Chalk, Strontia, Wolfram, Chrome, Terra-Alba, Rotten Stone, China Clay, Umbers, Ochres, Antimony, Calamine, Emery Stone, all Oxides, and all

FULLER'S EARTH—Of superior quality, and entirely free from grit. [BRAND, "EMERALD."]

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,

MINE PROPRIETOR,

Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.

OFFICES—26 CHAPEL STREET, LIVERPOOL.

KÖRTING BROTHERS,

ENGINEERS,

17, LANCASTER AVENUE, FENNEL STREET.

MANCHESTER.

Air Compresser.

UNIVERSAL INJECTORS FOR FEEDING BOILERS.

STEAM-JET EJECTORS for Vacuum up to 27 ins. mercury.
STEAM-JET AIR COMPRESSERS for oxidising Caustic Liquors.

WATER-JET AIR-PUMPS FOR LABORATORIES.
WATER-JET ELEVATORS FOR RAISING LIQUIDS.

STEAM-JET ELEVATORS
(Of Iron, Brass, or Lead), for Raising Liquids.

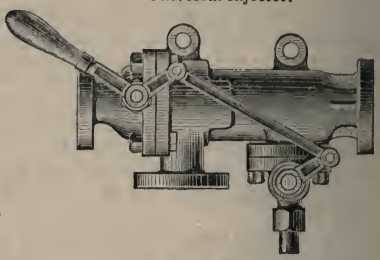
STEAM-JET VENTILATORS (made of Iron or Lead),
for Ventilating Drying Rooms, to draw Gases through Porous Materials, &c.

STEAM-JET CHIMNEY VENTILATORS to Increase Draught.

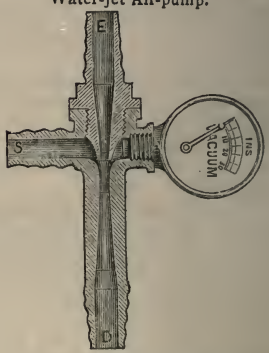
,, *BLOWERS for Heating Furnaces and Boilers.*

CIRCULARS AND TESTIMONIALS ON APPLICATION.

Universal Injector.



Water-jet Air-pump.



BISULPHIDE OF CARBON
PROTOSULPHATE
RED OXIDE
OXYCHLORIDE

Sulphocyanide,
And every other Mercurial Preparation.

BISULPHITE OF LIME, TETRACHLORIDE OF CARBON.
Oxysulphuret of Antimony, Glacial Acetic Acid,

LIQUOR AMMONIÆ,
SULPHIDE OF IRON,
PURE ACIDS,
CHLORIDE OF SULPHUR,
ACETONE,
CHLOROFORM,
ALDEHYDE,
CHLORATE BARYTA,
ARSENIC ACIDS,
FRUIT ESSENCES FOR CONFECTIONERY & LIQUEURS,
PERCHLORIDE OF IRON,
SULPHITE AND HYPOSULPHITE OF SODA,
PHOSPHATES OF SODA AND AMMONIA,
ETHERS,
BROMIDES,
IODIDES,
SCALE AND GRANULAR PREPARATIONS,
SULPHIDE OF SODIUM.

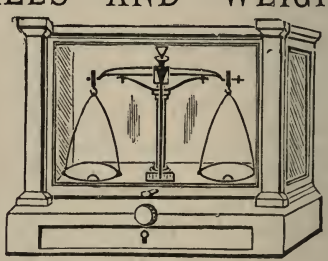
ALSO,
Pure Photographic Chemicals of every kind.
MANUFACTURED BY
WILLIAM BAILEY & SON,
HORSELEY FIELDS CHEMICAL WORKS,
WOLVERHAMPTON.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

BECKER & SONS,

MANUFACTURERS OF
CHEMICAL AND GOLD ASSAY BALANCES
AND OTHER
SCALES AND WEIGHTS.

ROTTERDAM.



NEW YORK.

BECKER'S STUDENT'S BALANCE, in polished mahogany glass case, sliding front, counterpoised, to carry 30 grammes in each pan and turn to ½ milligramme, nickel plated pans £2
Ditto, ditto, in mahogany glass case, polished black.. .. .. £2

Sole Agents for England, Ireland, and Wales:—
TOWNSON & MERCER.

Becker's Complete Lists forwarded by post on receipt of 1*d.* stamp or free on application.

BISULPHIDE OF CARBON,
CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,
161, 162, 163, PALMERSTON BUILDINGS, LONDON, E.C.

THE CHEMICAL NEWS

VOL. XLII. No. 1081.

NOTE ON SOME DOUBLE SALTS OF MECONIC ACID.

By EDWARD H. RENNIE, B.Sc. (Lond.),
Demonstrator of Chemistry in St. Mary's Hospital Medical School.

IN testing on one occasion for meconic acid, it was noticed, that if to a solution of that acid, chloride of calcium is first added in considerable quantity and then a small quantity of ferric chloride, a red precipitate is produced, and so long as the ferric chloride is not in excess, the supernatant fluid remains colourless. If, however, the ferric salt is added in sufficient quantity, the precipitate first formed re-dissolves on standing, producing the well known blood-red colour. If, instead of adding the chloride of calcium *first*, the meconic acid solution be mixed with some ferric chloride and *then* the calcium salt added, no precipitate is produced at first, but (unless the ferric salt be in considerable excess) a slight precipitate is deposited after a time. As these appearances seemed to point to the formation of a double salt, it was thought worth while to examine the matter a litte further.

The meconic acid used was re-crystallised twice, and gave on combustion numbers which shewed it to be practically pure. A quantity of the red precipitate mentioned above was prepared, and after thorough washing, heated to 100° for some time. Further experiment showed, however, that this temperature was insufficient to drive off all the water. It was then found, that up to 140° the substance gave off water only, that is, up to that temperature the loss of weight of the substance and the gain of weight of a chloride of calcium tube used to collect the water were practically equal, but that when the temperature was raised to 200°, the chloride of calcium tube ceased to gain in weight at anything like the same rate as the substance continued to lose weight. Three separate specimens of the substance were therefore prepared, dried at 140°, and analysed, with the following results, the numbers representing percentages:—

	A.	B.		C.
Carbon	—	29·11		29·45
Hydrogen ..	—	1·66		1·45
Iron	10·21	10·49	10·48	10·32
Calcium	10·69	10·58	10·77	10·91

These numbers appear to represent a substance of fairly constant composition, but it was not found possible to derive from them a very probable formula. The nearest formula appears to be $(C_7HO_7)_4Fe_2Ca_3.5H_2O$, which requires 30·37 per cent C, 1·27 per cent H, 10·09 per cent Fe, 10·81 per cent Ca.

Similar compounds are produced when barium or strontium chloride is substituted for the calcium salt. Two different specimens of the barium compound, also dried at 140°, gave the following percentages, which, however, do not agree nearly so well as the above:—

	A.	B.
Iron	9·63	8·93
Barium	28·80	29·93

These compounds are slightly soluble in cold, more so in boiling water, and separate out from the latter on cooling in an amorphous condition. Their solutions give no precipitate with ammonia and no colouration with potassic ferrocyanide until after the addition of an acid. They give no blue colouration with potassic ferricyanide after the addition of an acid, but only the brownish tint indicative of a ferric salt. Their solutions when treated with sulphuric acid and ether yield to the latter an acid which strikes a blood-red colour with ferric chloride.

ON THE

ELECTROLYTIC DETERMINATION OF NICKEL AND COBALT.

By H FRESENIUS and F. BERGMANN.

ACCORDING to former experimentalists, nickel and cobalt are not precipitated by the electric current from solutions containing free mineral acids, but both metals can be entirely thrown down from ammoniacal solutions and from the solutions of their cyanides in potassium cyanide. According to Luckow nickel and cobalt can be completely precipitated from solutions of their neutral sulphates mixed with alkaline acetates, tartrates, and citrates. Luckow seems to have used this method for the quantitative determination of the above metals, but no particulars are found in his memoir.

All other papers on the quantitative determination of nickel and cobalt by electrolysis refer to precipitation from an ammoniacal solution, which, according to previous experience, yields the metals in the state best adapted for weighing. For the success of the operation it is essential that the solution contains a sufficient excess of free ammonia, since the liquid must remain strongly ammoniacal during the whole course of the experiment. The precipitation is promoted by the presence of ammonium sulphate. Sodium phosphate has, according to M. S. Cheney and E. S. Richards, a similar effect. On the other hand, ammonium chloride retards or hinders the precipitation. The strength of the current and the respective distance of the electrodes are also of importance. The authors used a Clermond's thermo-electric battery of the construction described in *Zeitschrift f. Anal. Chemie*, xv., p. 333, made by Koch, of Eisleben. It consists of 120 elements, and was provided with the porcelain burner described and figured in *Zeitschrift Anal. Chemie*, xv., p. 334. The current produced by the apparatus evolves 300 c.c. detonating gas per hour from water acidulated with sulphuric acid. The platinum electrodes were of the form and size recommended by the Management of the Mansfeld Mines and Smelting Works. (See *Zeitschrift f. Anal. Chemie*, xi., p. 6.)

The electrolysis was performed upon 200 c.c. of liquid, contained in a beaker, covered with a watch-glass, having suitable apertures for the polar wires. The withdrawal of the liquid and the washing after the completion of the electrolysis took place without interrupting the current. The removal of the liquid was effected by means of a water air-pump; the authors using a flask closed with a stopper having two apertures. Through one of these passes a glass tube, not too wide, which projects a little into the flask, and which outside is bent twice at right angles, so that the free descending limb can be introduced into the beaker used for the electrolysis in such a manner that its end reaches nearly to the bottom of the beaker. By the aid of this arrangement, and with a proper regulation of the air-pump, the solution and the washing-water can be sucked out of the beaker into the flask regularly and not too rapidly. The beaker and the electrodes were easily and safely rinsed with the washing-bottle. Not until all this was completed the polar clamps were opened and the electrodes removed from the beaker. The cone (negative pole) with the metallic deposit to be weighed was dried upon a hot iron plate, let cool, and weighed. Rinsing with alcohol before drying, as occasionally recommended, was found superfluous.

In some preliminary experiments the authors confirmed the statements of their predecessors as to the precipitation of nickel and cobalt from ammoniacal solutions, especially as to the beneficial effect of ammonium sulphate and the injurious effects of ammonium chloride. It appeared, further, that quantities of 0·1 to 0·15 cobalt or nickel were completely precipitated by a current of the above strength in from five to six hours.

The nickel solution was prepared by dissolving chemically pure crystalline nickel sulphate in water with the

addition of a little dilute sulphuric acid, and diluted to a litre. In 50 c.c. of the solution the nickel was determined by precipitation, and weighed after ignition in a current of hydrogen. The quantity of nickel thus found was 0·1233 grm. = 2·4660 grms. per litre.

For preparing the cobalt solution metallic cobalt was employed, prepared by igniting chemically pure cobaltous oxalate. A suitable quantity was heated with water and nitric acid, the nitric acid removed by evaporation, diluted with water, filtered, and the filtrate made up to 1 litre. In 50 c.c. of this solution the cobalt was determined by precipitation as cobaltous oxide, and weighed as metallic cobalt. The result was 0·1283 grm., corresponding to 2·5660 grms. per litre.

A solution of ammonium sulphate was also employed containing 305 grms. per litre of the anhydrous salt, and liquid ammonia, of sp. gr. 0·96, that is containing 10 per cent NH_3. As the nickel was precipitated by the current the ammoniacal solution, which was at first blue, became paler, and finally colourless. This decolouration does not afford a certain indication of the conclusion of the operation, and it is requisite to ascertain by one of the known tests if nickel is still present in solution. The authors made use of a solution of potassium sulphocarbonate. When this reagent produces in the liquid merely an exceedingly faint rose tint the precipitation is complete. This colouration appears even when the quantity of nickel present has been precipitated to decimilligrammes. In the most successful experiments which gave a result differing from that obtained gravimetrically merely by 0·0005 grm., there were employed 50 c.c. of the ammonia solution, 100 c.c. ammonia, 50 c.c. ammonium sulphate, and 300 c.c. water. The electrodes were at the distance of 1 to 1½ c.m. from each other. Results nearly equal were obtained with 50 c.c. nickel solution, 40 to 50 ammonia, 10 to 20 c.c. ammonium sulphate, and water 100 c.c., the electrodes being distant from each other only ½ to ⅓ c.m.

In the experiments with cobalt the same strength of current was employed, and the conclusion of the process was ascertained by means of potassium sulphocarbonate, which produces a vinous yellow as long as the slightest traces of cobalt are present.

Ammoniacal solutions of cobalt are known to take up oxygen on exposure to the air, and become brownish red in consequence of the formation of roseo-cobaltic compounds. This phenomenon takes place with the solutions undergoing electrolysis. The original red colour becomes a light reddish brown, which darkens for a time until decolouration ensues, when the cobalt is precipitated. The authors' experiments show that cobalt is most perfectly precipitated if 50 c.c. of cobalt solution are taken along with 50 c.c. ammonia, 10 c.c. ammonium sulphate, and 80 c.c. water. The electrodes were at the respective distances of ½ to ⅓ c.m.

The presence of sodium phosphate does not interfere with the accuracy of the result, but it was not found to exert any favourable action, at least as far as cobalt is concerned.—*Zeitschrift für Analyt. Chemie.*

ON THE

ELETROLYTIC DETERMINATION OF SILVER.

By H. FRESENIUS and F. BERGMANN.

It is generally known that silver can be precipitated in a compact metallic state from the solutions of silver cyanide or chloride in potassium cyanide by means of the electric current.

As far back as 1865 Luckow demonstrated that silver may be quantitatively determined in this manner. He pointed out at the same time that electrolysis may be made available in other manners for the quantitative determination of silver; either—

(1.) By the reduction of silver chloride at the negative pole, or—

(2.) By the separation of the silver from a neutral solution of silver nitrate.

Concerning the latter process Luckow states:—"If the current from two Meidinger elements is conducted through a neutral dilute solution of silver nitrate, metallic silver in a spongy state is deposited on the platinum capsule which forms the negative pole, whilst at the same time the edge and the lower surface of the platinum disc forming the positive pole is covered with fine black needles of silver peroxide, which, however, disappear almost entirely on prolonged action of the current. If, when all the silver has been deposited, the supernatant liquid is decanted off, the separated metal is repeatedly washed with water, dried sharply, and the capsule weighed; the increase of weight gives the proportion of silver in the liquid a little lower than the reality. The loss is due to the fact that a small quantity of silver is deposited on the disc of the positive pole owing to the reduction of the peroxide."

In a more recent memoir on the application of the electric current in analytical chemistry (*Zeitschrift Anal. Chemie*, xix. p. 15), Luckow states:—

"Silver is precipitated by the electric current from solutions containing not more than 8 to 10 per cent of free nitric acid, in a very bulky metallic state; at the same time a little peroxide is deposited at the positive pole, the formation of which may be prevented by an addition of glycerine, milk-sugar, or tartaric acid." No further information has been published on the electrolytic separation of silver from nitric solutions.

In accordance with Luckow the authors observe that silver can be easily and completely precipitated from nitric solutions, whether neutral or containing free acid, but that it is disposed to take a spongy or flocculent form, so that it easily falls off from the electrode and cannot be readily weighed. The precipitate assumes this spongy state, especially when it has been deposited from a somewhat concentrated solution, by the action of a moderately strong current. By using dilute solutions and a weak current the authors have succeeded in throwing down the silver in a compact state, adhering firmly to the electrode and capable of being readily weighed. This result was only obtained in presence of free acid. From neutral solutions even a feeble current precipitated the silver in a flocculent state. The authors' experiments were conducted with the same apparatus described in their memoir on the determination of nickel and cobalt.

The following proportions appear suitable for obtaining the deposit of metallic silver in a compact form:—In 200 c.c. of liquid submitted to electrolysis there should be from 0·03 to 0·04 grm. metallic silver and 3 to 6 grms. free nitric acid, the electrodes being at a distance from each other of 1 c.m., and the strength of the current such as to evolve 100 to 150 c.c. detonating gas per hour.—*Zeitschrift für Analytische Chemie.*

ON THE

PROBABLE OCCURRENCE OF NORWEGIUM IN AMERICAN LEAD.

By GEO. A. PROCHAZKA.

C. W. Blomstrand reports (*Ber. d. Deut. Chem. Gesell.*, xii., 1731) on the discovery of norwegium by Tellef Dahll, substantially as follows:—

"On a small island Oterö, in the neighbourhood of Kragerö, where Mr. Dahll resides as mining director, towards the end of the year 1878, a calcite gangue, interspersed with small particles of copper, nickel, and nickel glance, was discovered. The nickel glance, on analysis, gave nickel, cobalt, iron, arsenic, and sulphur. The hydrogen sulphide precipitate was treated with ammonium sulphide to remove the arsenic; the black sulphide of a

new metal remained undissolved. 10 kilogrms. of the ore were then roasted; the residue was dissolved in acid and precipitated by H_2S. The precipitate was dried and again roasted; the oxide thus produced was reduced to metal.

Further investigation proved that the metal contained copper. To remove the copper the metals were converted into chlorides, and the solution diluted with a large excess of water. The new metal was thereby precipitated as oxychloride, while copper remained in solution. The new metal in its properties bears very close resemblance to bismuth.

	Bismuth.	Norwegium.
Melting-point	264°	254°
Atomic weight (R_2O_3)	210	218·9
Specific gravity	9·8	9·441

The oxides of both metals are fusible, and give in the flame, on porcelain, a metallic mirror. The main difference between the two metals consists in the solubility of the oxyhydrate of the new metal in caustic alkali, as well as in ammonium and sodium carbonate solution, on boiling. The difference is well marked if carbonates are treated in the same manner.

In the course of an examination of American refined lead, containing comparatively large quantities of copper and nickel, the bismuth had been precipitated in the ordinary manner by an excess of sodium carbonate, from the potassium cyanide solution of the 5th group of metals (Fresenius). In the alkaline filtrate, H_2S produced a reddish brown precipitate, which could not be identified as the sulphide of any of the well known heavy metals. It was readily soluble in dilute nitric acid. From this solution a basic salt was precipitated by water. Potassium carbonate produces a precipitate which is soluble in an excess of the boiling precipitant. Hydrogen sulphide precipitates the original sulphide from the alkaline solution.

The quantity of sulphide was very small, amounting to about 1 m.grm. from 200 grms. of lead.

The reactions, as far as they could be verified, considering the smallness of the quantity of material, correspond to the description of norwegium as given by Dahll.

The refined lead was a mixture of leads from various sources, but it is not improbable that there may be a connection between the presence of copper, nickel, and norwegium. Proper attention given to the various lead ores, especially those which yield lead containing larger quantities of copper and nickel, will undoubtedly throw further light upon this subject.

The results obtained seemed of sufficient interest for publication for the benefit of those who may be more favourably situated, both with regard to time and material, than I am at present.—*Journal of the American Chemical Society.*

CONTRIBUTIONS TO THE CHEMISTRY OF BAST FIBRES.*

By E. J. BEVAN and C. F. CROSS.

Before proceeding to lay before this Society an account of the results which Mr. Bevan and myself (the paper was read by Mr. Cross) have obtained as the reward of two years' work in a comparatively new field of chemical research, we will devote a few minutes to the consideration of the more general aspects of our subject matter.

Casual observation reveals, in the larger number of the commoner plants, the existence of a fibrous layer, of greater or less tenacity, situated towards the cortical portion of the stem; the fibres themselves composing this tissue descend vertically and rectilinearly, forming thin concentric plates, and to this circumstance the tissue owes its name of liber. The symmetrical distribution of these fibres is especially marked in the stems of certain dicotyledonous plants, the bast of which constitutes the basis of important textile industries. Flax, hemp, jute, China grass, are the isolated liber of the most characteristic of such plants. The mode of separation adopted varies in each case, according to the degree of adhesion between the liber and the cortical elements on the one hand, and the true wood on the other. One of the simplest, and that of the greatest antiquity, having been employed and brought to considerable perfection by the Chinese and Japanese long before our civilisation had dawned, is the manipulation of the paper mulberry (*Broussonetia papyrifera*), for the production of the paper peculiar to these nations. The stems of five years' growth are cut down and boiled for twenty-four hours in water, the cortex and bast are then easily stripped together from the wood. By further soaking in water for twenty-four hours, and drawing the strips through a scraper, the cortical cellular tissue is easily removed. Subsequent boiling in an alkaline liquid, obtained by lixiviating wood-ashes, and washing in a running stream brings about the removal of the last traces of cellular tissue and the complete isolation of the bast fibres. These are easily felted by striking them with wooden mallets; lastly, a natural size obtained by boiling the root of the *Hibiscus manihot* is applied, and, after drying, the remarkable paper which is so extensively used in Japan is obtained. An equally simple manipulation, for the purpose of a more curious application of the bast which is thereby isolated, is extensively practised by the South Sea Islanders; the bread fruit tree (*Atrocarpus incisa*) similarly treated, readily yields its bast. This is worked, by the simple process of felting, into a cloth capable of use for clothing and other purposes. Perhaps the most curious and rudimentary of these simple processes is that which is applied to the *Antiaris saccidora*, a tree which is common in the jungle of several districts of the Indian peninsula. A stem or branch is cut, soaked for a short time in water, and beaten with clubs. The liber is then stripped as a perfect cylinder to within a few inches of one extremity, the wood is sawn through at this point, and the bast restored to its original position, now forming, together with the disk of wood, a perfect sack, which is used for carrying rice and for other similar purposes. The isolation of the textile fibres previously mentioned involves a more complicated process, which moreover requires to be varied to suit the requirements of each case. A brief description of the method employed in the preparation of the jute fibre will enable us to bring out the general principles upon which other similar though more complicated processes are based. Jute, in common with the other bast fibres which are applied to textile purposes, is obtained from a dicotyledonous annual. The corchorus species which yield it are cultivated chiefly in India by the Ryots, or native tenant farmers. The stems are slender and bear leaves, but are seldom branched except at the summit. The sowing takes place usually in the rainy season (March-April), the harvest about August, when the flowering is over, the stems having attained a height of 10 to 12 feet, and a thickness of 7 or 8 inches. Having been cut down close to the ground, and freed from leaves and seed-pods, the stems are tied into loose bundles, weighted with stones, and submerged in stagnant or slowly running water. After the lapse of five to ten days the "retting" is complete: the bast and cortical tissue are stripped together from the wood, and separated from one another by a rapid to and fro motion beneath the water. The bast, thus freed from cellular elements, is dried in the sun, made into bales, and in this form exported. From the specimen on the table you will see that in the aggregate condition the fibre is about 7 feet long, and of a colour varying from a dark brown (towards the root as well as throughout the fibre in the lower qualities) to silver-grey. The fibres are matted together by a resinous constituent, and in order to fit them for the operations of combing they are subjected to the preliminary treatment of "batching." This consists in moistening the fibre with a mixture of oil (whale oil together with petroleum) and water, applied separately and carefully distributed; the solvent action of

* Read before the Owens College Chemical Society, April 16, 1880.

this mixture on the resinous matters being aided by passing the moistened fibre through a long series of pairs of heavy fluted rollers (" breaking " or " crushing "), or, in the case of finer qualities, stacking it and allowing it to remain for two or three days. The fibre is then ready to undergo the usual textile processes of combing, carding, spinning, and weaving. These are explained sufficiently for our purpose by the specimens on the table. The processes adopted in the case of other fibres differ from the above in detail only; we shall therefore pass over them to the consideration of the constitution of these interesting plant elements, keeping jute before us as the type, a selection which we shall find justified by many subsequent considerations. Examining with the microscope a preparation of the raw fibre, previously boiled in water and mounted in glycerine, we find that we have a number of cylindrical threads, showing parallel, longitudinal, and transverse markings; further, that adhering to these threads, which we shall presently see are bundles of the ultimate fibres, are a number of yellowish, resinous masses. Taking now a fresh portion similarly mounted after boiling in strong alcohol, we observe no change as regards the fibres, but the masses which we described as resinous appear now as colourless parenchymatous tissue. The alcohol has removed the resin, which, adhering previously to the fibres on the one hand and parenchyma on the other, prevented the complete separation of the latter in the original retting process. In this observation we have the *rationale* of the batching process before described. This resinous parenchyma we may dismiss therefore as a foreign body.

To isolate the pure bast we have always adopted the plan of boiling for a few minutes with dilute ammonia, which also dissolves the resin, the fibre sustaining a loss of 1 per cent in weight. Taking the fibre thus treated, mounted after teasing, we shall find that the bundles are now disintegrated, and the structure of the ultimate " fibrils " is apparent. They are cylindrical for the most part, tapering to a fine point at either extremity (this is discovered by tracing the fibres to their termination). The central lumen is well defined; in some cases its diameter is four-fifths of that of the whole fibre, and its outline regular. In other cases we find that this regularity gives place to an indented outline, in consequence of irregular thickening of the cell walls, the lumen being often obliterated by the cylinder becoming solid at intervals. This feature is more prevalent in the fibres of the early growths (root ends), but is often observable in the later. Variations from limit to limit are not infrequently met with in the contiguous fibres of the same bundle. In no portion of the length, therefore, can jute be said to present a constant structure of its constituent fibrils.

From structure we pass to chemical composition, which we shall consider first in the aggregate. The percentage of inorganic (ash) constituents is small, vary from 0·6 in the finer qualities to 2·0 per cent in the less fine. It is almost entirely soluble in hydrochloric acid. We have not made complete analyses, as our attention has been taken up by the more absorbing questions involved on the organic side. The following results of partial analyses are nevertheless worth recording, as they exhibit the main features of the inorganic skeleton of the fibre:—

SiO_2	33·73	34·43	37·66
Fe_2O_3	5·53	6·67	8·33
Mn_3O_4..	0·75	0·43	0 88
CaO	16·67	17·82	13·84
MgO	5·81	—	2·98
Al_2O_3	6·15	5·14	5·24
P_2O_5	13·87	8·39	8·85
SO_3	—	5·35	1·23
Cl	—	0·87	—

The ash contains in addition about 10 per cent carbonic anhydride, formed during combustion, leaving a balance of 5-10 per cent for the alkaline constituents.

The presence of manganese is noteworthy. Some varieties of flax exhibit the same peculiarity. A remarkable feature of the ash of this, as indeed of all fibres, is that in it the structural peculiarities of the original are accurately preserved, suggesting an essential relationship of this skeleton to the organic portion of the structure. An inorganic constituent of considerable importance is the water of hydration of the fibre. This is constant at from 10 to 12 per cent of its weight, varying within these limits with the temperature and hygroscopic condition of the air. Its relations to the fibre have been the subject of some experiment and speculation. Sir William Thompson is inclined to regard the phenomenon as involving the laws of capillarity only, as dependent therefore upon the tubular structure of the fibre; but he advances no satisfactory evidence for neglecting the chemical nature of the fibre substance, which seems to us the essential cause of its hydration. Union with water of hydration, and the capacity of removing bodies such as colouring matters from solution, are properties which exist in colloid substances in a close and general connection, especially marked in those substances which play a prominent part in the economy of living nature, and that whether they are organised or not. This correlation we have every reason to regard as essential. Finding, moreover, that the structureless modification of the fibre substance, obtained by precipitation from its solution in ammonio-cupric oxide, has the same tendency to take up water, and that the microscopic investigation of the fibre, dyed in various ways, gives no evidence of variation of tinctorial capacity with variations in structure, we prefer to class this, together with the capacity for hydration of the fibre, with the group of phenomena included in the term chemical adhesion.

We now pass to the consideration of the most interesting problem of the nature and constitution of the organic portion of the fibre. In laying before you the results of our researches, I may say that we do so with much pleasure; we all of us owe a great deal to this College, some of us to this Society, and it is a satisfaction to make a return, however small, in presenting the results of work undertaken in a new and rich field of research; but we do this not without some hesitation, for they are necessarily incomplete, and when each day's work throws fresh light on the points involved it is difficult to break off at a given stage of imperfection and make them the subject of a paper. However, we are more confident in doing this before a young society of fellow students, especially as the discussion which will follow will doubtless be of much help in bringing our results to the stage in which they may be laid before an older society. In order to give point to our treatment of the subject we shall speak from and to a theoretical view of the chemistry of the jute fibre, which, although it generalises our results, we do not regard as yet established. First, as to the aggregate elementary composition of the fibre. In this, as in all similar determinations, it was necessary to take specimens representing an entire length of the plant. These were purified by boiling in ammonia, washing, and drying at 105° C. previous to the combustions. The following results were obtained:—

(*a*) 0·4105 gave 0·7035 CO_2 and 0·2155 H_2O (together with 0·003 ash).
(*b*) 0·385 gave 0·6425 CO_2 and 0·1995 H_2O (0·003 ash).
(*c*) 0·3665 gave 0·6 4 CO_2 and 0·1905 H_2O (0·006 ash).
(*d*) 0·375 gave 0·6185 CO_2 and 0·1955 H_2O (0·006 ash).

After deducting the ash the calculated numbers are—

	(*a*)	(*b*)	(*c*)	(*d*)	Cellulose.
C ..	47·09	45·86	46·4	45·44	44·44
H ..	5·86	5·80	5·7	5 84	6·17

The mean percentage of carbon is 46·3. Associated with the cellulose basis of the fibre there is therefore a body or group of bodies rich in carbon. These amounting, as we shall presently see,* to about 30 per cent of the

* The percentage of nitrogen is so small that it may be neglected. Thus, 1337 grains of the fibre, after boiling in dilute sodium carbonate and drying, yielded, after ignition of platino-chloride, 0·0052 pt. corresponding to 0·053 per cent nitrogen—a quantity just appreciable.

weight of the fibre, we calculate them to contain in the aggregate about 50 per cent of carbon. Still keeping to the question of aggregate composition, we come to treat of the methods adopted for the isolation of the cellulose. Of these there are several, all dependent, however, upon the solubility of the bodies with which it is associated, after previous treatment with an oxidising agent, in boiling alkaline liquids. Schulze's method, which up till quite recently was exclusively employed, consists in digesting the fibre (1 part) for twelve to fourteen days, at 15° C., with a solution of 8/10 part $KClO_3$ in 12 parts of HNO_3 (sp. gr. 1·1), washing with cold and then with hot water, boiling in dilute ammonia (1 in 50), and lastly washing with water, alcohol, and ether. This method is imperfect, the product being often discoloured, and by no means pure, and is now generally superseded by that proposed by Hugo Müller, viz., treating the fibre with aqueous bromine in the cold, and subsequently boiling in dilute ammonia, repeating the process until bromine ceases to be taken up. Dr. Müller found that a very pure cellulose was thus obtained; and as, moreover, he observed that specimens of cellulose left for months in contact with aqueous bromine underwent no change, the method appeared in every way reliable. In investigating the *rationale* of the process in the care of the jute fibre, we found that there occurred not only an oxidation of the intercellular substance, but also bromination; the halogen product being decomposed by ammonia, with formation of products soluble in the alkaline liquid. The direct action of a halogen alone, of which we shall treat hereafter, especially in regard to the products formed, suggested itself as a much more rapid and satisfactory method of acting upon these bodies than in solution in water; and in fact we found that by means of chlorine we were able in a few hours, and with once repeating, to arrive at the same result as by Müller's method, which involves four or five repetitions, occupying from two to three days.

We will now introduce a demonstration of the isolation of cellulose in this way. This specimen of jute has been boiled in a weak alkali, and exposed in the moist state to the action of chlorine. It now exhibits the deep orange yellow colour of the chlorinated compound which has been formed. Plunging it into boiling dilute alkali the compound is decomposed, the solution becoming of a dark brown colour through taking up the products. Throwing the fibre on to a muslin filter, and washing with hot water, we obtain a disintegrated soft mass of a transparent brown colour. A small portion plunged into acid is for the most part decolorised, and now exhibits an appearance not far different from that of the pure jute cellulose. We will repeat the process on the remainder, and thereby arrive at a practically pure product.

We will discuss the two latter methods somewhat more in detail.

(*a*) *Müller's Method.*—The percentage obtained by this method—*i.e.*, the alternate action of bromine water and boiling dilute ammonia—varies from 70 to 72 in the finer varieties of jute. The results obtained are very constant. The rough criterion of the completion of the process is the homogeneity of the disintegrated mass; the purity of the cellulose is ascertained by plunging it into a hot weak solution of aniline-blue, by which any residual intercellular matter will be dyed to a bright tint, easily distinguishable, after thorough washing, from the pale greyish shade which represents the low limit of the dyeing capacity of the pure cellulose. (It is needless to say that the weight of the mass is not sensibly affected by the test.) With regard to the manipulation of the fibre, the washings are best carried out on square filters of well-bleached (printer's) calico. For digesting with the bromine water, the most convenient vessel is a common china mug (300 c.c.) indelibly lettered. For all weighings, before and after treatment, the substance is previously dried at 105°.

(*b*) *Chlorine Method.*—The results obtained are equally constant and identical with the above, *e.g.*—

4·374 grns., previously boiled in water, yielded 3·127 = 71·3 per cent cellulose.
4·363 grns., previously boiled in dilute Na_2CO_3 yielded 3·195 = 72·2 per cent cellulose.
4·346 grns., previously boiled in dilute Na_2CO_3 yielded 3·161 = 72·7 per cent cellulose.

A more rapid result is in both methods attained by previously boiling the fibre with dilute alkali (1 per cent NaOH); the yield of cellulose does not appear to be affected. The following results were obtained with the process thus modified :—

Bromine Method.—

4·430 yielded 3·108 = 70·1 p.c. (boiled 10 min. in alkali).
4·420 ,, 3·153 = 71·3 ,, (,, 60 ,, ,,).

Chlorine Method.—

4·150 yielded 2·889 = 70 per cent.
3·900 ,, 2·748 = 70 ,,
4·332 ,, 3·069 = 70·8 ,,

The effect of boiling in a stronger alkali (5 per cent NaOH) is still further to aid the subsequent chlorination without otherwise affecting the results unless the boiling be prolonged.

Bromine Method.—

5·504 yielded 4·014 = 72·9 per cent (boiled 5 min.)
4·544 ,, 3·265 = 71·8 ,, (,, 60 ,,)
6·519 ,, 4·577 = 70·2 ,, (,, 4 hrs.)

It is advantageous to boil in a weak solution of caustic soda (1 per cent) after chlorination, this alkali being a better solvent for the products of decomposition than ammonia; and the results do not appear to be otherwise influenced by the substitution of the former.

The yield of cellulose resulting from the above treatment is, it will be seen, fairly constant; but this is incidental to the fact that the process of disintegration has been uniformly arrested at the point when the product satisfied the conditions of purity above mentioned; but at this point it is by no means an end product. The following results may be selected to show that the "72 per cent cellulose," as we may call it, is further considerably acted upon by the alternate action of bromine water and ammonia :—

Original weighings—

$$\text{A.}\quad \frac{3\cdot400\times100}{4\cdot689}=72\cdot5\text{ p.c.} \qquad \text{B.}\quad \frac{4\cdot06\times100}{5\cdot673}=71\cdot6\text{ p.c.}$$

After twice repeating bromine treatment—

$$\text{A.}\quad \frac{3\cdot224\times100}{4\cdot689}=68\cdot7\text{ p.c.} \qquad \text{B.}\quad \frac{3\cdot884\times100}{5\cdot673}=68\cdot4\text{ p.c.}$$

After two further repetitions—

$$\text{A.}\quad \frac{3\cdot025\times100}{4\cdot689}=64\cdot5\text{ p.c.} \qquad \text{B.}\quad \frac{3\cdot780\times100}{5\cdot673}=66\cdot6\text{ p.c.}$$

We have not investigated the limit of this conversion into soluble products, but another process for isolating cellulose will throw light on this point. When the fibre is digested for some hours with dilute nitric acid (5 per cent) at 70°, a portion of the intercellular substance, both aromatic and carbohydrate, is dissolved, the solution acquiring a bright yellow colour and an odour resembling that of vanille: the remainder is modified in such a way that it is dissolved on boiling the fibre with a dilute alkali, and pure cellulose remains. The following percentages have been in this way obtained :—61·4, 60·8, 61·6, 62·7, 63·7, 62·8, 61·6. These results will be subsequently developed and discussed. We may therefore infer the presence of a constituent in jute cellulose, readily susceptible of conversion into a soluble modification, and that the cellulose isolated by the more usual quantitative methods is a chemical aggregate, defined by the process of which

it is the product. These observations are extended and confirmed by a modification of our chlorination process which we have only recently adopted. This consists in plunging the chlorinated fibre into a boiling solution of sodium sulphite: its colour changes from orange to purple, and a considerable quantity of its substance is dissolved. It is then boiled in a weak alkali (1 per cent NaOH), and pure cellulose is obtained thus with a single chlorination. The yield of cellulose is in this case higher than by any of the previous methods; *e.g.*, we have obtained 75·2 and 76·4 per cent, the product moreover possessing a much greater length of fibre. On twice treating the resulting cellulose according to Müller's method these quantities were diminished to 72·6 and 73 per cent respectively, numbers which are still above the average of former methods. Even when the process, modified as above, was supplemented *before weighing* by the latter treatment, the percentage yield was still above the average, *e.g.*, 74·7, 75·4, 76·9.* The inference from these results is that the intercellular substance contains a body of the nature of cellulose which may, in the process of re-solution, be separated partially in the insoluble form as cellulose, and partly as a soluble modification, the ratio of these being dependent upon the process employed. We may mention here, in support of this view, that on exhausting the chlorinated fibre with water, a body is dissolved which reduces Fehling's solution; and, on subsequently boiling with an alkali, the solution obtained has the same property. We shall discuss these points more fully hereafter, and show that there is reason for regarding the bodies to which the reducing action is due as carbohydrates. In concluding this portion of our subject we would point out the necessity of "defining" the cellulose obtained in the proximate analyses of plant structures, by a statement of the method of separation, and we would open the next by pointing out a similar want of clearness which attaches to the terms by which the intercellular and encrusting substances are chemically defined. In giving the results of such analyses it is usual to sum these constituents under the term "pectous substances." This seems to us an *a priori* assumption not necessarily to be verified by a special examination into their chemical nature.

(To be continued.)

* Several subsequent applications of the bromine and ammonia treatment caused in these, as in previous similar cases, a relatively small decrease in weight, viz., from 74·7 to 72·3, from 76·9 to 74·5, and from 75·4 to 74 per cent, proving a marked influence of the sulphite treatment on the stability as well as on the yield of the cellulose.

UNIFORMITY IN CHEMICAL NOMENCLATURE.

With the object of securing a nearer approach to uniformity in chemical nomenclature and the symbolic representation of formulæ and decompositions, the Council of the Chemical Society some time ago drew up certain rules and recommendations for the use of their Journal staff. We gladly accede to the request that we should publish the following extracts from them in our columns, in the hope that they may induce our readers in general to adopt a system which, coming from such a source, may be considered authoritative wherever chemistry is studied:—

"Equations, as a rule, should *not* be written on a separate line, but should 'run on' with the text. Simple reactions involving a mere interchange of radicles, or the withdrawal or addition of a particular element or group of elements, need not generally be expressed by equations.

"Employ names such as sodium chloride, potassium sulphate, ethyl acetate, and only use the terminals *ous* and *ic* in distinguishing compounds of different orders derived from the same elementary radicle, *e.g.*, mercurous and mercuric chloride, sulphurous and sulphuric acid.

"Apply the term *acid* only to compounds of hydrogen with negative radicles, such as HNO_3, H_2SO_4, H_3PO_4, and denote the oxides which form acids by names such as sulphuric anhydride or sulphur trioxide. Term salts containing an amount of metal equivalent to the displaceable hydrogen of the acid *normal* and not neutral salts, and assign names such as hydrogen-sodium sulphate, hydrogen-disodium phosphate, &c., to the acid salts. As a rule, it is best merely to give the *formulæ* of basic salts.

"To economise space, it is desirable, 1, that *dots* should be used *instead of dashes* in connecting contiguous symbols or radicles whenever this does not interfere with the clearness of the formula; 2, that formulæ should be shortened by the judicious employment of the symbols Me for CH_3, Et for C_2H_5, Pr$^\alpha$ for $CH_2.CH_2.CH_3$, Pr$^\beta$ for $CH(CH_3)_2$, Ph for C_6H_5, $\bar{A}c$ for $CO.CH_3$, and $\bar{B}z$ for $CO.C_6H_5$; and 3, that formulæ should be written *in one line* whenever this can be done without obscuring their meaning. For example:—

$CCl_3.CH(OEt)_2$ instead of $CCl_3-CH\begin{matrix}OC_2H_5\\OC_2H_5\end{matrix}$

$(CCl_3.CH.OH)_2S$ instead of $\begin{matrix}CCl_3-CH-OH\\CCl_3-CH-OH\end{matrix}\!\!>S$

$CH_2 : CH_2$ instead of $CH_2{=}{=}CH_2$

$CH \vdots CH$ instead of $CH{\equiv}{\equiv}CH$

$CH \vdots C.CH_2.CH_2.C \vdots CH$ instead of $\begin{matrix}CH_2-C{\equiv}{\equiv}CH\\ |\\CH_2-C{\equiv}{\equiv}CH\end{matrix}$

$MeCH : CHPr^\alpha$ instead of $CH_3.CH{=}{=}CH.CH_2.CH_2.CH_3$

$COOH.CH : CMe.COOH$ instead of $\begin{matrix}CH_3-C{=}{=}CH\\ |\quad\quad |\\COOH\quad COOH\end{matrix}$

$CH_2Br.CBrMe_2$ instead of $\begin{matrix}CH_3\ CH_3\\ \diagdown\ \diagup\\ CBr\\ |\\ CH_2Br\end{matrix}$

$\bar{A}c.CEt_2.COOEt$ instead of $\begin{matrix}CH_3\\ |\\ CO\\ |\\ C<\begin{matrix}C_2H_5\\C_2H_5\end{matrix}\\ |\\ COOC_2H_5\end{matrix}$

$\begin{matrix}CH_2.CH.Me\\CH_2.CH.Me\end{matrix}\!\!>O$ instead of $\begin{matrix}CH_2-CH.CH_3\\ |\quad\quad\diagdown\\ |\quad\quad O\\ |\quad\quad\diagup\\CH_2-CH.CH_3\end{matrix}$

$C_6H_5CH(\bar{O}Bz).CH(\bar{O}Bz).COOEt$ instead of $C_6H_5.CH(O.CO.C_6H_5).CH(O.CO.C_6H_5).COOC_2H_5$.

"Use names such as methane, ethane, &c., for the normal paraffins or hydrocarbons of the C_nH_{2n+2} series of the form $CH_3.(CH_2)_x.CH_3$. The isomeric hydrocarbons are usually most conveniently represented by names indicating their relation to methane: for example, $CH_3.CH_2.CH_2.CH_3$ = propylmethane; $CH_3.CH(CH_3)_2$ = isopropylmethane or trimethylmethane; or, although less frequently, by names such as diisopropyl.

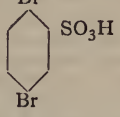
"Term the hydrocarbons C_2H_4 and C_2H_2 ethylene and acetylene respectively (not ethene and ethine). Distinguish the homologues of ethylene whenever possible by names indicating their relation to it, such as methylethylene, dimethylethylene, &c., denoting the di-derivatives of the form $C_nH_{2n+1}.HC{:}CH.C_nH_{2n+1}$ as α-, and those of the form $CH_2{:}C(C_nH_{2n+1})_2$ as β- compounds: thus, $CH_3.CH{:}CH.CH_3$ = α-dimethylethylene; $CH_2{:}C(CH_3)_2$ = β-dimethylethylene. Similarly, use names such as methylacetylene and dimethylacetylene for the homologues of acetylene of the form $CH \vdots C.C_nH_{2n+1}$ and $C_nH_{2n+1}.C \vdots C.C_nH_{2n+1}$. Adopt the name *allene* for

the hydrocarbon $CH_2{:}C{:}CH_2$, and indicate the relation which its homologues bear to it in the same manner as pointed out for acetylene.

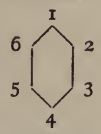
"In representing the constitution of benzene derivatives, as a rule, merely indicate the relative positions of the radicles in the symbol of benzene by figures, instead of by means of the hexagon symbols, as in the following example:—

Paradibromobenzenesulphonic acid,—

$C_6H_3Br_2.SO_3H[Br:SO_3H:Br=1:2:4]$ instead of—



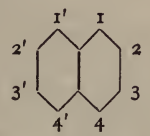
the figures always being used in the order—



Relatively to the position 1, the positions 2 and 6 should always be spoken of as *ortho*-positions, 3 and 5 as *meta*-positions, and 4 as the *para*-position. It is better, however, in speaking of the derivatives of benzene, to express their constitution by giving them names such as 1:2 dibromobenzene, 1:3 dibromobenzene, &c., rather than by terming them ortho- or metadibromobenzene, &c.

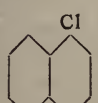
"In representing the constitution of derivatives of other 'closed chain' hydrocarbons also, as rule, do not employ graphic formulæ, but merely indicate the position of the radicles introduced in the following manner:—

"*In the case of naphthalene*, express the position of the radicles introduced in place of hydrogen relatively to the carbon atoms common to the two 'rings,' and number the positions in the one ring 1, 2, 3, 4, and those in the other 1', 2', 3', 4' in the order shown by the annexed symbol:—

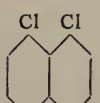


"The dichloronaphthalenes, for example, are spoken of simply as 1:2 dichloronaphthalene, or dichloronaphthalene [Cl:Cl=1:2], &c., thus—

1:2 dichloronaphthalene=

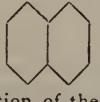


1:1' dichloronaphthalene=

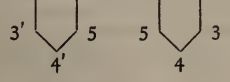


1:3 dichloronaphthalene=

1:3' dichloronaphthalene=



"*In the case of diphenyl*, indicate the position of the radicles relatively to the carbon atom of the one C_6 group which is associated with the other C_6 group, and number the positions in the one group by the figures 2, 3, 4, 5, 6, and the corresponding positions in the other group by the figures 2', 3', 4', 5', 6', as shown by the following symbol:—

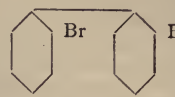


Thus the mono-derivatives, the bromodiphenyls, for example, are represented as—

Bromodiphenyl [Br=2]
" [Br=3]
" [Br=4]

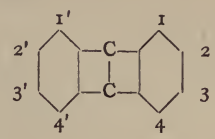
and the two dibromodiphenyls—

and



are respectively dibromodiphenyl [Br:Br=2:3] and dibromodiphenyl [Br:Br=2:6'].

"*In the case of anthracene*, employ the following symbol, and indicate the position of the radicles relatively to the central C_2— group:—



Examples:—

Alizarin, $C_6H_4{:}C_2O_2{:}C_6H_2(OH)_2[OH:OH=1:2]$.

Quinizarin, $C_6H_4{:}C_2O_2{:}C_6H_2(OH)_2[OH:OH=1:4]$.

Anthraflavic acid,—

$C_6H_3(OH){:}C_2O_2{:}C_6H_3(OH)[OH:OH=2:3']$.

Purpurin, $C_6H_4{:}C_2O_2{:}C_6H(OH)_3[OH:OH:OH=1:2:4]$.

"In speaking of compounds such as these, their constitution may be represented by the names—

1:2	Dihydroxyanthraquinone	= Alizarin.
1:4	"	= Quinizarin.
2:3'	"	= Anthraflavic acid.
1:2:4	Trihydroxyanthraquinone	= Purpurin.

Always include the letters and figures indicating the constitution of derivatives of closed chain hydrocarbons in square brackets.

"Distinguish all alcohols, *i.e.*, hydroxyl-derivatives of hydrocarbons, by names ending in *ol*, *e.g.*, quinol, catechol, resorcinol, saligenol, glycerol, erythrol, mannitol, instead of hydroquinone, pyrocatechin, resorcin, saligenin, glycerin, erythrite, mannite. Compounds which are not alcohols, but which are at present distinguished by names ending in *ol*, may be represented by names ending in *ole*, if a systematic name cannot be given. For example, write indole instead of indol; furfuraldehyde instead of furfurol; fucusaldehyde instead of fucusol. Ethers derived from phenols, such as $C_6H_5.OCH_3$, &c., hitherto called anisol, anethol, &c., may be distinguished by names ending in *oïl*, as anisoïl, anethoïl.

"Alcohols should be spoken of as mono-, di-, tri-, or n-*hydric*, according to the number of OH groups.

"Bodies such as the acids of the lactic series containing the group (OH) should be termed *hydroxy*-, and not oxy-derivatives, *e.g.*, hydroxyacetic and not oxyacetic acid. Compounds containing the analogous groups C_2H_5O, C_6H_5O, $CH_3.COO$, &c., should in like manner be termed ethoxy-, phenoxy-, acetoxy- derivatives. Thus, ethoxy-propionic acid instead of ethyl-lactic acid; 3:4 diethoxybenzoic acid instead of diethylprotocatechuic acid; and acetoxypropionic acid instead of acetyllactic acid. Terms such as diethylprotocatechuic acid should be understood to mean a compound formed by the displacement of hydrogen atoms in the hydrocarbon radicle of protocatechuic acid by ethyl, viz., $C_6H(C_2H_5)_2(OH)_2.COOH$, and not $C_6H_3(OC_2H_5)_2.COOH$, just as dibromoprotocatechuic acid is understood to be the name of a compound of the formula $C_6HBr_2(OH)_2.COOH$.

The term *ether* should be restricted to the oxides of hydrocarbon radicles, and the so-called compound ethers should be represented by names similar to those given to the analogously constituted metallic salts.

"Compounds of the radicle SO_3H should, whenever

possible, be termed sulphonic acids, or, failing this, sulphocompounds: as benzenesulphonic acid, sulphobenzoic acid, and not sulfi-compounds. Compounds of the radicle $SO_2.NH_2$ should be termed sulphonamides.

"Basic substances should invariably be indicated by names ending in *ine*, as aniline, instead of anilin, the termination *in* being restricted to certain neutral compounds, viz., glycerides, glucosides, bitter principles, and proteids, *e.g.*, palmitin, amygdalin, albumin. The compounds of basic substances with hydrogen chloride, bromide, or iodide, should always receive names ending in *ide* and not *ate*, as morphine hydrochloride and not morphine hydrochlorate."

NOTICES OF BOOKS.

A Manual of Quantitative Chemical Analysis, for the Use of Students. By F. A. Cairns, A.M., Instructor in Analytical Chemistry in the School of Mines, Columbia College. New York: H. Holt and Co.

This book consists substantially of the notes and instructions given by the late F. A. Cairns to the students at the School of Mines. At the time of his sudden and lamented death, he was collecting the subject-matter for the present work, which has been completed by his friend and colleague, Mr. Elwyn Waller. The art of quantitative chemical analysis is here taught, not by taking the pupil through the series of simple bodies and their compounds in the order usually met with in chemical treatises, but it is illustrated upon a number of commercial products and natural minerals so arranged that each may prepare the way for the determination of the succeeding bodies. Thus the first substance which the author puts into the hands of the student is barium chloride, upon which he illustrates the determination of baryta and of chlorine.

In the analysis of potable waters, the author recommends for the determination of organic matter that the permanganate process, as elaborated by Dr. Tidy, be superadded to the ammonic process of Wanklyn and Chapman. For the determination of phosphoric acid in superphosphates, he prescribes the ammonium molybdate method, making use of the volumetric uranium process only in the absence of iron and alumina. Reverted phosphoric acid he dissolves out in the usual way with ammonium citrate.

For the examination of white-lead ground up in oil,—a somewhat puzzling case for the inexperienced,—he removes the oil by digestion at a steam-heat with excessive and repeated doses of ether or gasoline. The oxides and metallic salts are then determined in the residue by ordinary methods.

In the analysis of milk Mr. Cairns determines moisture, or total solids, by simple evaporation on the water-bath without the previous addition of sand or plaster-of-Paris.

After closely examining the directions here given for the analysis of the various substances, as well as the more general instructions in the introduction, we recognise that the author was a careful and conscientious analyst, accustomed to lay due weight upon certain precautions necessary for the attainment of accurate results, but which are, nevertheless, often slurred over in the text-books. If there is any point upon which we should differ from him, it is in reference to his directions that filters and their contents should be thoroughly dried before ignition. This, save in a few exceptional cases, is a mere waste of time.

The Retrospect of Medicine. Edited by W. Braithwaite, M.D., and James Braithwaite, M.D. Vol. lxxxi., January—June, 1880. London: Simpkin, Marshall, and Co.

This half-yearly summary contains not a little matter which will be found interesting beyond the limits of the medical profession. As such we may particularly mention a paper on "Contagion, its Nature and Mode of Action," by J. Simon, F.R.S. The author points out that the self-multiplying power of all contagia is strongly suggestive of their being not merely organic, but organised and endowed with life. He draws the following distinction between parasites and true, or metabolic, contagia. Each of the latter, in proportion as it multiplies in the body, transforms the bodily material with which it comes in contact in a specific way, different from the ways of other contagia. The parasite, on the contrary, however much it multiplies in the body, produces no qualitative effect specific to itself, but only such effects as are common to it and all other parasites. As one of the modes in which parasitic disease is spread, Mr. Simon mentions that in Iceland the very great sufferings of men and cattle from *Echino coccus* have been traced to the agency of dogs. These animals eat hydatidised offal from the slaughter-houses, and then void the eggs of the tape-worm in kitchen-gardens, water-courses, and pastures.

Another memoir, entitled "A Contribution to the Therapeutics of Starch Digestion," by Dr. W. Roberts, F.R.S., is also of general interest. The author finds that the pancreatic secretion of suckling calves does not act as a ferment of starch, and considers it probable that the same rule will hold good in young children, whose saliva is well known to have but a very feeble diastatic power. The practical conclusion from these facts is the unsuitableness of farinacea of all kinds,—unless accompanied by some ferment, such as extract of malt—for the nutriment of infants. Dr. Roberts recommends that a simple infusion of malt in cold water should be added to gruel or other farinaceous preparations.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 2, July 12, 1880.

Observations on the Density of the Vapour of Iodine.—M. Berthelot.—It is admitted in the abstract theory of gases that the simple gases experience at once the same increase of total energy and the same increase of the *vis viva* of translation when they undergo one and the same change of temperature. This conception explains the experiments of physicists on the specific heat of gases (the law of Dulong and Petit), on their expansion by heat (the law of Gay-Lussac), and on their compressibility (Mariotte's law). It may further be inferred from the two latter laws that the density of a gas, that is to say, the relation between the weight of a given volume of this gas and the weight of the same volume of air, taken at the same temperature and at the same pressure, is constant. The variations hitherto observed have been ascribed to secondary perturbations. These three laws have never been really demonstrated except for three elements (oxygen, hydrogen, and nitrogen); they constitute the sole scientific basis upon which is founded the physical determination of molecular weights, and consequently the numeration of atoms in actual theories. If these laws should cease to be true for certain elements, the physical definition of the molecular weights of these elements and that of the number of their atoms would become mere conventions. The author has already observed that the experiments of Kundt and Warburg on the velocity of sound in mercurial vapour cannot be reconciled with the totality of the three laws just referred to (*Annales de Chimie et de Physique*, 5th series, ix., p. 427). The experiments of M. V. Meyer on the decrease of the gaseous

density of iodine and of the other halogens under a constant pressure, but at temperatures remote from each other, are still more at variance with admitted laws. These experiments are, moreover, confirmed and extended by those which M. Troost has just performed with his usual precision on the same body at a constant temperature, but at varying and slight pressures. Thus the variation of the *vis viva* of the molecular translation of gaseous iodine under the influence of very high temperatures or of very slight pressures far surpasses the same variation in the molecules of air, observed under the same conditions. The laws of Mariotte and of Gay-Lussac, founded merely on three simple gases, are applicable neither to iodine nor to the other halogens. We may here call to mind that the law of specific heats is not applicable to this group of elements, as the specific heats of chlorine and gaseous bromine exceed by one-fourth those of the other simple gases, even between the ordinary temperature and 200°, at which no dissociation is admissible. Hence it results that the increment of the total energy of the halogens with the rise of temperature exceeds that of the three other gases hitherto studied (nitrogen, hydrogen, and oxygen) as well as the increment of the *vis viva* of translation: these two orders of effects appear correlative. The decrease of the density of gaseous iodine being, moreover, progressive, it is the same with the increase of the *vis viva* of translation, and it is not permissible, as M. Troost has very judiciously remarked, to draw from it any correct conclusion as regards the variation of the number of the molecules. This kind of reasoning becomes arbitrary the moment that the molecular weight of iodine, either at a high temperature or at a low pressure, escapes from the old definitions. A single law remains applicable to the elements with an absolute and universal character: the invariability of the relations of weight according to which the elements combine with each other, that is to say, the notion of equivalents. It is at present the sole immoveable foundation of chemical science.

Formation-heat of Hydrocyanic Acid and of the Cyanides.—M. Berthelot.—The author has rectified his determinations, published in 1871, in conformity with the amended formation-heat of ammonia, formerly taken as +35·15 but now found to be +21·0. The corrected formation-heats of the cyanogen compounds are given in the form of a table.

Vapour-densities of Selenium and Tellurium.—MM. Sainte-Claire Deville and Troost.—The authors communicate the details of the experiments which they performed in 1860. For selenium the vapour-density found was 5·68, or by calculation 5·54. For tellurium the experimental result was 9·08, or by calculation 8·93.

Etiology of Rinder-Pest.—M. Pasteur, with the assistance of MM. Chamberland and Roux.—The author considers that the buried bodies of animals which have perished may still propagate the infection, as the disease-germs are brought to the surface by earth-worms. Hence he argues that animals should never be buried in lands used for pasturage or for the cultivation of forage plants. Such carcases should if possible be buried in poor, dry, sandy, or calcareous soils where earth-worms do not prosper. The cattle disease is unknown in the chalky "Savarts" district of Champagne.

Ammonia in the Air and the Waters.—Albert Lévy.—The author has made during the years 1875-79 inclusive, regular analyses of the rain-waters collected at a number of points in and around Paris. The yearly mean proportion of ammonia, expressed in milligrammes per litre, has been 1·98, 1·54, 1·91, and 1·20. The water is poorest in ammonia in July and August, whilst the maximum proportion appears in December. As regards the atmosphere the case is reversed. The proportions of ammonia found in 100 cubic metres of air were, in 1876-77, 3·0 m.grms.; in 1877-78, 2·3, and in 1878-79, 1·9.

Fluorine Compounds of Uranium.—A. Ditte.—The author has obtained the hydrofluorate of uranium sesquifluoride, $U_2F_3 4HF$, in yellow transparent crystals. He has formed also an uranyle fluoride, $(U_2O_2)F$. This latter compound if heated is decomposed into a volatile oxyfluoride and a sesquioxide, which is very unstable and loses a part of its oxygen and becomes transformed into a protoxide, which crystallises in the fluoric atmosphere.

The Constitution of Matter and the Ultra-Gaseous State.—Extract from a letter addressed by Mr. Crookes to M. Dumas.

Mono-chromatic Lamps.—L. Laurent.—This paper cannot be reproduced without the accompanying illustration.

Telephonic Effects resulting from the Shock of Magnetic Bodies.—M. Ader.—The author draws the general conclusion that every mechanical action having the effect of disturbing the state of molecular equilibrium of a magnetic nucleus, develops, at the moment when such nucleus returns abruptly to its conditions of equilibrium, an electric current capable of acting on the telephone.

Atomic Weight of Scandium, and on Certain of its Characteristic Salts.—L. F. Nilson.—The author has operated upon scandia extracted from euxenite. The properties by means of which it is possible to separate scandia from ytterbia are:—Scandium nitrate is decomposed by heat more readily than ytterbium nitrate: scandium sulphate added to a saturated solution of potassium sulphate produces a double salt, which is entirely insoluble. The atomic weight, assuming scandia Sc_2O_3, is 44·03. Scandia is a very light infusible white powder, resembling magnesia or glucina, and of the sp. gr. 3·864. The author describes the nitrate, sulphate, double potassium sulphate, selenites, and oxalate. He considers that scandium is the element which Prof. Mendelejeff predicted under the name of ekabor.

Ultimate Action of Bromine upon Malonic Acid: Bromoform.—E. Bourgoin.—Malonic acid is in great part attacked by bromine with the formation of bromated acids of little stability, so that the final reaction is expressed by the following equation:—

$$C_6H_4O_8 + 3Br_2 = 2C_2O_4 + 3HBr + C_2HBr_3,$$

a reaction comparable to that which yields tetrabromated ethane by means of succinic acid.

Etherification of Sulphuric Acid.—A. Villiers.—Sulphuric acid in presence of alcohol may give rise to an acid and a neutral ether, but the quantity of the latter is exceedingly small. As in the case of the hydracids, etherification ceases entirely on reaching a certain degree of dilution, but with sulphuric acid the same solutions cease to become etherified at common temperatures and at 100°, contrary to what takes place with the hydracids.

Biedermann's Central-Blatt für Agrikultur-Chemie.
Part 3, March, 1880.

Observations on Local Fluctuations of the Proportion of Carbonic Acid in the Atmosphere.—Drs P. Häsellbaith and J. Fittbogen.—At Rostock the atmospheric carbonic acid decreased with a south-west wind, and increased with a north easterly current. In Dahme, on the contrary, the proportion was greatest with a westerly wind. Rain and dew was found to produce a slight diminution; fog, in some cases, a decrease, and in others an increase. No influence was traced to sunshine and shade.

Comparative Meteorological Observations in Fields and Forests.—A. Matthieu.—On an average of eleven years the rain in two stations of the woods as compared with the open country was found to be in quantity as 100 and 97 to 81, and in spite of the screen of leaves the proportion which reaches the soil is as large, or larger than in the fields. In the fields the average evaporation is three times greater than in the forests. In the forests the extremes of temperature are smaller and the fluctuations less

Injurious Effect of Water from Peat Moors and Alder Swamps upon Meadows.—Dr. Klien.—These waters contain large proportions of soluble humic compounds, which, among other things, reduce all iron compounds to ferrous salts, which exert a poisonous influence upon the soil.

"Separation-Mud" as Manure.—Prof. E. v. Wolff.—The mud in question is formed on clarifying beet juice with lime. It contains 1 to 2 per cent of phosphoric acid and about ¼ per cent of nitrogen.

Cultivation of an Estate for Thirty-eight Years without Farm-yard Manure.—M. Stecker.—This estate has been exclusively treated with artificial manures, and no cattle have been kept. The yield of rye and oats is better than on the neighbouring estate of Bräunsdorf, which is abundantly dressed both with dung and artificial manures. In potatoes the returns are lower, and clover and flax have failed.

Manurial Experiments with Nitrate of Soda on Sugar-Beets.—Prof. Max Märcker.—The yield of sugar was found inferior in value.

Manurial Experiments on Rye, Wheat, and Oats.—Dr. A. Pagel and H. Meyer.—Not suitable for abstraction.

Experiments on Feeding Swine.—Prof. E. v. Wolff.—It has been ascertained that the nutritive effects of animal and vegetable albumen are substantially identical.

Chemical Researches on the Activity of Bees.—Dr. E. Erlenmeyer and A. v. Planta-Reichenau.—Wax is produced, not from nitrogenous, but from non-nitrogenous matter, especially sugar. The food of bees should not be very rich in albuminous compounds. They refused food containing peptons. Carbo-hydrates are expended in producing the tissue-fat of bees.

Determination of the Non-albuminoid Nitrogenous Compounds of Plants.—Dr. O. Kellner.—In clover, lucern, sorghum, &c., peptons neither exist pre-formed nor are produced by the treatment used by the experimentalists. During the germination of such plants, however, peptons make their appearance.

Germination of Beet-seed.—P. van de Putte.—Warm and insular climates are unsuitable for the sugar-beet, which is richest where early cold sets in after a hot summer.

Seed-production of Red Clover.—Dr. G. Haberlandt.—The author recommends the protection of humble bees and the diligent destruction of their enemies.

Researches on the Damage to Peas by Bruchus Pisi.—Prof. G. Marck.—Pea seed damaged by this weevil cannot be recommended for sowing. The author proposes to treat the peas with the vapour of carbon disulphide.

Tartar and Tartaric Acid in Must and Wine.—E. Mach, C. Portele, and C. v. Babo.—On the average as the percentage of alcohol (in volume) rises from 5 to 19, the tartar falls from 3·3 to 1·2. The free tartaric acid varies from 0 to 1·9. The absence of tartar in the presence of free tartaric acid is a proof that the wine has been plastered.

Tannin in Wines.—Ippolito Macagno.—Where alcohol is deficient tannin has not a preservative action. As wines grow older the glycerin increases and the tannin diminishes.

The Chemical Changes in Nitrogenous Matter due to Fermentation, and their Relation to the Growth and the Efficiency of Yeast.—Dr. M. Delbrück.—The absolute quantity of the yeast formed does not depend on the dissolved sugar, and is affected merely by the quantity of dissolved nitrogen. The formation of yeast is not connected with its fermentative efficiency.

Action of Products of Putrefaction upon Schizomycetes.—M. Wernich.—The bacteria of putrefaction appear to prepare materials for their own destruction. Phenol, cresol, scatol, indol, &c., all of them products of the putrefaction of albuminoid substances, interfere with the development of bacteria.

The Raw Material for Pressed (so-called German) Yeast.—Dr. M. Delbrück.—The author recommends the coarsest quality of rye.

Influence of the Galvanic Current upon Bacteria in a Mineral Nutritive Solution.—Prof. C. Cohn and Dr. B. Mendelsohn.—A battery of five elements destroys bacteria completely, and if fresh living bacteria are subsequently introduced they do not increase. Induction currents have no influence upon the multiplication of bacteria.

Justus Liebig's Annalen der Chemie,
Band 202, Heft 2.

Derivatives of Myristic Acid.—F. Masino.—The author finds the melting-point of myristin between 53° and 54°, which accords with theory and differs totally from Playfair's determination (31°). The derivatives examined are myristamide, myristanilide, and myristolic acid.

Crystalline Constituents of Coralline.—C. Zulkowsky.—The author criticises the memoir on Aurin (*Annalen*, 194, 75) by R. S. Dale and C. Schorlemmer. He remarks that after these chemists had for years upheld the formula $C_{20}H_{14}O_3$ for aurin, they now put the matter in such a light as if the researches of E and O. Fischer were in certain respects merely a confirmation of views, which they have in the meantime corrected. He states that Dale and Schorlemmer's method of preparing coralline requires more time than his own, yield much smaller returns, and produces, not pure aurin, but a mixture o several bodies, crystalline and amorphous. He adds the following recent observations on the manufacture of coralline:—It is not advantageous to heat the mixture of sulphuric acid and phenol in order to complete the formation of sulpho-phenol. The proportion of ⅔ part of sulphuric acid given in the author's earlier prescription should be reduced to ½ part, and the oxalic acid should be used in a dehydrated state. Good results were obtained by mixing 1 part phenol with ½ part sulphuric acid of 66° B., adding 0·6 to 0·7 part dehydrated oxalic acid, and heating to 120° to 130° until the escape of gas has become decidedly weaker, and the contents of the flask on cooling become a tough mass. About twenty-four hours are required for the completion of the process and the yield ranges from 60 to 70 per cent. Among the compounds specially examined are oxidised aurin, $C_{19}H_{16}O_6$, in violet needles; leucaurin, $C_{19}H_{16}O_3$; aurin, $C_{19}H_{14}O_3$; methyl-aurin, $C_{20}H_{16}O_3$; and its leuco-product, $C_{20}H_{18}O_3$.

Constitution of Certain Naphthalin Derivatives.—F. Beilstein and A. Kurbatow.—The two nitro-groups in α-dinitro-naphthalin are distributed to both the benzol-nuclei, whilst in β-dinitro-naphthalin they are in one benzol-ring.

Communications from the Laboratory of Owens College, Manchester. 1. Examination of Certain Cases of Isomorphism.—H. Baker.—After the examination of a number of double fluorides and oxy-fluorides, the author remarks that among all these salts there is a very close analogy of form, with two exceptions. On optical examination a difference appears, some of them being singly and others doubly refractive. If certain chemically analogous bodies, belonging to the same crystalline system, distinguished merely by small differences in their angles, and therefore regarded as amorphous, have very different optical properties, should not other bodies of mutually analogous composition also rank as isomorphs, though they have been placed in different systems on account of small differences in the magnitude of their angles or in their optical behaviour?

2. The Atomic Weight of Tellurium.—W. L. Wills. The atomic weight of tellurium is 126·83 with a probable error of 0·198. Hence it does not fall between iodine and antimony, but exceeds that of iodine, which therefore

ought to rank before tellurium in Mendelejeff's classification.

3. On Magnesium Vanadiates.—S. Suguira and H. Baker.—The authors describe the brown salt,—

$$3MgO5V_2O_5,28H_2O,$$

and a red salt of the same composition.

4. Certain Fluorine Compounds of Vanadium.—H. Baker.—The author describes the potassium fluoroxy-vanadiate in a foliaceous and an acicular form; a corresponding ammonium salt, foliaceous, pyramidal, and acicular; a zinc fluoroxy-vanadiate, and an ammonium fluoroxy-hypo-vanadiate.

Communication from the Laboratory of the University of Halle.—This consists of a paper by W. Heintz on two compounds of urea with gold chloride.

Archives Néerlandaises des Sciences Exactes et Naturelles.
Tome xv., livraison 1.

The Diamond Mine of South Africa.—J. A. Roorda Smit.—The author summarises his observations as follows:—In the mines of South Africa the diamond is found in a primitive gangue, of volcanic origin, and which has merely experienced secondary modifications. The presence of the double carboniferous silicate is characteristic for these diamond mines, which are the extinct craters of volcanoes. In consequence of the plutonic phenomena the diamond has been formed at the expense of organic matter, under the influence of great pressure and a high temperature.

Tome xv., livraison 2.

Researches on Conquinamine.—A. C. Oudemans, Jr.—Already noticed.

The Phenomenon of Flashing in the Assay of Gold, and the Influence Exerted upon this Phenomenon by the Metals of the Platinum Group.—A. D. van Riemsdijk.—Already inserted.

Correspondenz-Blatt des Vereines Analytischer Chemiker.
No. 6, March 15, 1880.

Determination of Carbohydrates in Infants' Foods.—Dr. N. Gerber.—The author proposes the following method:—In a capsule of platinum or porcelain, holding 50 c.c., are put 2 or 3 grms. of the sample, taken from the middle of the package, and mixed with ten times the weight of water. (1.) In foods containing diastase proceed according to the directions for mixing given upon the package, making use of the thermometer. The mass is allowed to cool, placed in a tall beaker, holding 150 to 200 c.c., and this capsule is then washed with 100 c.c. of alcohol at 50° Tralles. Let stand over night, when the clear supernatant liquid can be easily drawn off with an aspirator. When the liquid has passed through, the precipitate is thrown upon the filter, and the beaker is washed upon it with 100 c.c. of alcohol at 50° Tralles. (2.) In ordinary foods, 1 part is also mixed up with 10 parts of water, and kept at a boil for exactly five minutes with constant stirring, and further treated as above. In order to determine the soluble carbohydrates the filtrate is evaporated down to quarter of its volume, separated by filtration from the albuminates and fatty matters, and then evaporated first in the water-bath, and then in the air-bath, at 100° to 110° till the weight becomes constant. The residue is lastly carefully incinerated. Then capsule + ash is subtracted from capsule + solid residue, the difference = soluble carbohydrates.

Microscopic Examination of Water.—This method of examining waters is strongly urged upon the attention of public analysts, and many of the more characteristic animal and vegetable forms are figured in the accompanying plate.

Occurrence of Indium in Norwegian Minerals.—S. Wleugel.—The author has examined many specimens of blende from different localities in the hope of finding indium. The minerals were as a rule either free from this element or showed very faint indications.

Proportion of Phosphates in the Moselle Wines.—R. Kayser.—These wines may contain 0·040 grm. P_2O_5 in 100 c.c.

No. 7, April 1, 1880.

Determination of the Decolourising Power of Different Samples of Animal Charcoal by Quantitative Spectrum Analysis.—C. H. Wolff.—Not suitable for abstraction.

Detection of Traces of Carbonic Oxide in Atmospheric Air.—C. H. Wolff.—This memoir requires the accompanying illustration. The apparatus described is made by Muenke Bros., Lonisenstrasse, Berlin.

Extraction-Apparatus for the Determination of Fats, Alkaloids, &c.—F. Gantter.—This paper cannot be usefully reproduced without the accompanying three figures.

Phosphoric Acid in Wine.—R. Kayser.—The author is not of opinion that the total phosphoric acid present in wine is in combination with soda.

Die Chemische Industrie.
No. 4, April, 1880.

Testing Petroleum for its Inflammability.—R. Haas.—The flashing is ascertained by the aid of electric sparks. The apparatus cannot be intelligibly described without the accompanying cuts.

Disposal of Furnace Smoke.—Prof. C. Winckler.—The author describes the methods adopted for dealing with the very sooty and sulphurous smoke of the ultramarine works at Bockau. Absorption in milk of lime and in coke-towers, down which water was allowed to trickle proved impracticable. The most satisfactory results were obtained by allowing the gases to pass through granulated limestone plentifully moistened with water.

Composition and Analysis of the Manganese Peroxide Regenerated According to Weldon's Process.—G. Lunge.—See Chemical News, vol. xli., pp. 129 and 141.

Manufacture of Sulphuric Acid.—A. Houzé.—The author brings sulphurous acid, watery vapour, and air in contact at high temperatures, but below redness, and condenses the product in a series of stone-ware vessels.

Technical Extraction of Phosphoric Acid from Mineral Phosphates.—A. Houzé.—After mechanical purification the phosphates are treated with hydrochloric acid, the solution is diluted with water, decanted or filtered, and the solution treated with sodium sulphate as long as any lime is precipitated. The filtrate contains the phosphoric acid along with sodium chloride, which is removed by crystallisation.

DIE LICHT-MÜHLE.

In einem leeren Runde
Da geht ein Licht-Mühl' Rad
Die Luft ist d'raus verschwunden
Die dort gewohnet hat.

Durch Pumpen und durch Kochen
Bleibt fast nichts mehr darin.
Ach weh! Er ist gebrochen!
Mein Glück ist nunmehr hin.

Ich möcht' als närriger Hatter
Wohl ziehn von Ort zu Ort
Betrachtend Radiant Matter
Or any other sort.

Seh' ich 'ne Licht-Mühl' gehen
Ich weiss' nicht was sie will.
Ich kann es nicht verstehen
Warum sie bleibt nicht still.

A. v. Nudeln.

ACTIEN-GESELLSCHAFT
FÜR
ANILIN-FABRIKATION,
BERLIN,

Manufacturers of Aniline Colours for Dyeing and Printing on Silk, Wool, Cotton, Leather, &c.

WORKS—Rummelsburg and Wiesenufer, near Berlin.
OFFICES—Treptower Brücke, S.O.
TELEGRAM—"Anilin," Berlin.

MANUFACTURERS OF

RUBINES,	Engl. Patent, No. 243 (1878)	ACID YELLOW	Germ. Patent, No. 4186
ACID-RUBINE	,, ,, 2828 (1879)	MALACHITE GREENS,	Engl. Patent, No. 828 (1878)
PONCEAUS	,, ,, 1715 (1878)	ACID MALACHITE GREEN	,, ,, 4406 (1878)
BORDEAUX	,, ,, 1715 (1878)	BENZYLE BLUES	
PHOSPHINES		WATER BLUES	
MANDARINES			

Eosines	Cotton Scarlets	Bismarck Brown
Rosaniline Base	Aurantia	Aniline Gray
Safranines	Picric Acid	Methyle Greens
Coccines	Methyl Orange	Spirit Blue
Nigrosine	Hofmann Violet	Humboldt Blue
Coralline	Marine Blue	Alkali (Nicholson) Blue
Aurine	Paper Blue	Guernsey Blue
Martius Yellow	Mode Brown	Gentiana and Royal Blue
Berlin Brown	Nacarate	and Gray Pastes
Regina Violet	Bavarian Blues	China Blue
Methyle Violets	Night Blue	Indigo Blue

ANILINE OILS
ANILINE SALTS IN CAKES AND CRYSTALS
MIRBANE OIL
METHYLE ANILINE

Samples and Prices on Application. *Special Terms to Merchants and Shippers.*
ALL GENUINE PACKAGES ARE PROTECTED BY TRADE-MARK.
*** Our Rubine (Magenta), and all Colours derived therefrom, are manufactured without employing Arsenic Acid.

SPECIALITIES.

MANGANESE—Finest Crystallised, Lump, Ground, and Granulated of every quality, and PREPARED for *Chlorine, Glass, Steel, Ferro-Manganese, Pottery, Battery*, and EVERY PURPOSE.

BAUXITE—(Hydrate of Alumina) Of high percentage of Alumina and almost free from Iron. The CHEAPEST, BEST, and MOST PROFITABLE article from which to produce ALUM, ALUM CAKE, and SULPHATE OF ALUMINA, &c. [BRAND, "IRISH HILL BAUXITE."]

FLUOR-SPAR—Of the Very Finest Quality for Acid, Soda, Glass Flux, and all purposes.

BARYTES—(Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

CRYOLITE—Magnesite, Felspar, Arsenic, Phosphates, French Chalk, Strontia, Wolfram, Chromic, Terra-Alba, Rotten Stone, China Clay, Umbers, Ochres, Antimony, Calamine, Emery Stone, all Oxides, and all

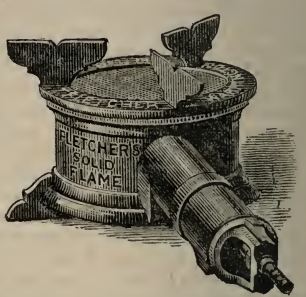
FULLER'S EARTH—Of superior quality, and entirely free from grit. [BRAND, "EMERALD."]

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,
MINE PROPRIETOR,
Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.
OFFICES—26 CHAPEL STREET, LIVERPOOL.

BISULPHIDE OF CARBON,
CHLORIDE OF SULPHUR.
GAS PURIFICATION & CHEMICAL CO., LIMITED,
161, 162, 163, PALMERSTON BUILDINGS, LONDON, E.C.

Fletcher's SOLID FLAME Burner.



Will with equal ease boil an egg in a small tin saucepan, or melt half-a-hundredweight of lead in an iron pot. It will boil half-a-gallon of water in a flat copper kettle in six minutes, and will melt 6 lbs. of lead or solder in an iron ladle in seven minutes. Price, Japanned, 4s.; nickel plated, 5s. Complete list of GAS FURNACES for all purposes; Hot and Cold Blast BLOWPIPES; Automatic, Foot, and Hand BLOWING APPARATUS; INSTANTANEOUS WATER HEATERS, &c., Price 3d., post free, with reprint of Mr. Fletcher's paper on the application of gaseous fuel to laboratory work, to which was awarded the Silver Medal of the Society of Arts.

THOS. FLETCHER,
4 & 6, MUSEUM STREET, WARRINGTON.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

THE CHEMICAL NEWS.

Vol. XLII. No. 1082.

ON PHOSPHORUS ESTIMATION IN IRON AND IRON ORES.

By Professor v. EGGERTZ.

The *Verhandlungen des Vereins zur Beforderung des Gewerbfleisses*, 1877, p. 267, contained a prize paper on a process for the estimation of phosphorus, by O. Korschelt, Professor in the Medical School of Yeddo, in Japan (translated in *The Metallurgical Review*, No. 5, p. 469; also communicated to *Berg. und Huttenm. Zeitung*, 1877, p. 195).

In this process the author makes some observations against my note on phosphorus estimation, published in 1859, and has proposed several improvements on it.

Prof. Korschelt thus expresses himself on my method:—"This process suffers still from some imperfections which cause much trouble in its technical application," and chief among such are the following:—

1. "The evaporation of the iron solution before precipitation." For iron *ores* this evaporation is unavoidable. For iron this is neglected here, and is done only with cast-iron containing much silicon. The dissolving of the iron must always be performed with the greatest care.

2. "For precipitation it requires two or three hours." Where speed is necessary, the iron as well as the molybdate solutions may be previously warmed to 40°; the time required for precipitation can thus be shortened to one or two hours. The solution may be allowed to stand covered for six hours at 40°, but not longer with safety, from the danger of some free molybdic acid precipitating.

3. "Drying at 95° demands much time." In my process I mentioned that the yellow phospho-molybdate precipitate can be dried for several hours at 120° to 140°, without undergoing special change in composition. The alteration is so unimportant, that after drying at 95° to 1·63 per cent of phosphorus, then drying at 120°, it will be 1·64 per cent. This tells only on the third or fourth decimal in its percentage in iron, if the amount of phosphorus is not very great. With me the drying is very often at a higher temperature than the water-bath.

4. "As phospho-molybdate of ammonia has the property of losing ammonia in drying at a constant temperature of under 100°, I (Prof. Korschelt) have therefore, instead of molybdate of ammonia, used a solution of molybdate of potassa for precipitation of phosphoric acid, and thereby completely avoided the tediousness of Eggertz's process in precipitation and drying." If the variation in the composition of the phospho-molybdate of ammonia precipitate, and its drying, is only as that given above, what more is there to say about it?

5. "The process has a source of error which certainly may be overcome by long practice, but which causes every one who has worked out the composition of the phospho-molybdate of ammonia to obtain a different figure for its percentage than his predecessors."

In my published process complete and detailed directions are given for its practice, and deviations therefrom are not allowed. Working by it is so easy, and gives such good results, that the students of the Mining School—where this method for over twenty years has been exclusively used—after executing two or three phosphorus estimations on only 1 grm. of iron, seldom obtain greater differences than 0·01 per cent, and only variations of 0·002 per cent to 0·003 per cent for less amounts of phosphorus.

The amount of phosphoric acid given by me—3·74 per cent (1·63 per cent phosphorus)—as in the yellow precipitate obtained by exactly the same means as in phosphorus estimations in iron, is the average of a great number of estimations, with 3·7 per cent as the minimum, and 3·75 per cent as the maximum. Prof. Korschelt, with molybdate of potassa as the precipitant, has obtained on average 3·96 per cent phosphoric acid (1·73 per cent phosphorus).

Prof. Rammelsberg undertook estimations according to Prof. Korschelt's method, and by three trials arrives at the conclusion that the amount of phosphorus in the precipitate of phospho-molybdate of potassa must be taken at 1·768 per cent, instead of 1·73 per cent, if obtained from an iron solution, and at 1·847 per cent if from an iron free solution.

Prof. Korschelt prepares his molybdate solution from molybdic acid, caustic potassa, tartaric acid, and nitric acid. This mixture is boiled, by which some molybdic acid separates out. This is filtered off, and the filtrate preserved. Prof. Korschelt remarks, "that tartaric acid is subject to a slow decomposition; he therefore recommends that a molybdate solution which has been kept a long time, should have a small quantity of tartaric acid added before using."

The ammonia molybdate solution used by me commonly maintains its stability; only a little free molybdic acid separates after a long time. The use of tartaric acid as an addition cannot come into question, because this impedes the precipitation of the phosphorus, at least under the usual time of one or two hours, and also causes a great evolution of gas.

Prof. Korschelt heats his molydate solution on the water-bath before using, and, further, warms "a short time" after precipitating. When arsenic is present, heat only to 50°. The precipitate is taken on a weighed filter, and washed first with water containing 3 per cent nitric acid, and then with alcohol, dried afterwards at 120° to 130°, and weighed. So much nitric acid in the wash-water acts sensibly as a solvent on the precipitate, and this is also the case with alcohol. I add only 1 per cent nitric acid to the wash-water, and continue the washing only so long as an evaporated drop of the wash-water leaves a scarcely noticeable ring.

For the estimation of phosphorus in iron Prof. Korschelt prescribes as follows:—"Take about as much iron as that the yellow precipitate will weigh 0·5 to 0·75 grm. Therefore if the iron contains 1 per cent phosphorus about 1 grm. is required."

Besides the great inconvenience of requiring beforehand to know the probable amount of phosphorus present in the iron, it follows also when—as is often the case in Sweden—the iron has phosphorus only to the amount of about 0·01 per cent, 100 grammes must be taken for estimation instead of 1 gramme. To dissolve 100 grammes iron requires about 1000 c.c. nitric acid. But here Prof. Korschelt prescribes that "You ought never to allow the iron solution to exceed 50 c.c."!

Concerning the process Prof. Korschelt says further:—"If the heating is not continued until free molybdic acid begins to separate, there is thus found remaining in solution only a very small quantity of phosphoric acid. I have considered it unnecessary to estimate this amount; the loss thus resulting in every case cannot be of greater influence in the analyses made by this method than some hundreds per cent."

Such phosphorus estimations are, at least in relation to Swedish experiments, altogether unsatisfactory, because here the amount of phosphorus is seldom found higher than 0·1 per cent. The most common amount lies between 0·01 and 0·05 per cent.

It is now easy to see from the above that my method does not demand more labour and little more time than Prof. Korschelt's. By collecting the precipitate in a funnel tube, pressing it together, and measuring, as described in my process, *small* amounts of phosphorus can be estimated in much shorter time.

Prof. R. Finkener gives in *Berichte der Deutschen Chemischen Gesellschaft*, 1878, p. 1638, directions to dis-

solve the phospho-molybdate precipitate upon the filter, evaporate the solution, and then heat so strongly that the nitrate of ammonia is removed (at about 200°). The greater part of the water is therewith expelled, and the composition of the salt will be as follows:—

$3P_2O_5+72MoO_3+8NH_4O+H_2O$, or

Phosphoric acid	3·794	(P=1·66)
Molybdic acid	92·341	
Ammonia	3·705	
Water	0·160	
	100·000	

Prof. Finkener thus expresses himself upon the Korschelt process:—"It follows from what Prof. Korschelt prescribes that in an iron containing 0·1 per cent phosphorus, none will be found present."

In the *Journal of the Chemical Society*, March, 1878, Mr. Ed. Riley communicates the magnesia method used by him for the estimation of phosphorus in iron. In the hands of Mr. Riley it is without doubt executed with great accuracy. In comparing it with my process we find:—

I. That with reference to precision in weighing the precipitates, we require to use seventeen times greater amount of iron (17 grms.) because the ignited pyrophosphate of magnesia contains 27·95 per cent phosphorus, but the phospho-molybdate of ammonia only 1·63 per cent phosphorus.

II. That the magnesia method demands much more time, labour, and skill.

III. That besides nitric acid I use no other reagent which can contain phosphoric acid, while Mr. Riley uses a magnesia salt, citric acid, also acetate of soda, and sulphite of soda. These last-named reagents are exceedingly difficult to procure completely free from phosphorus; I have not been so fortunate.

In this circumstance lies, perhaps, the explanation that Mr. Riley, as he says, often obtains about 0·02 per cent higher phosphorus in iron than several other chemists.—*Fern Kontorets Annaler* (1880, part 6, p. 355).

ON THE

VARYING CONDITION OF CARBON IN STEEL, AND ITS INFLUENCE ON EGGERTZ'S COLOURATION PROCESS.

By J. SPEAR PARKER, F.I.C.

The ease and rapidity with which results can be obtained by means of Eggertz's colouration process for the estimation of carbon, have rendered its adoption almost universal in the laboratories of steel works. I believe, however, that most chemists using the process have occasionally noticed anomalous results, which have aroused suspicions as to its reliability, and some I know have used it while regarding the results obtained as only roughly approximate. For my own part, exercising minute care in every stage, I used it for many years in the belief that its results could be fully depended upon; and although my suspicions had been once or twice excited, I was not at all prepared for the very serious variations to which after a thorough investigation I discovered it was liable. The standard I at that time habitually employed was of crucible steel, and agreed in its colour indications with others in use in several large works in this country, and with one or two test-bars from Sweden with which I had compared it. But I first became convinced that something must be seriously wrong with the process on the receipt from my friend, Mr. A. H. Allen, of drillings from a sample of hard Bessemer steel in which he had carefully estimated the carbon by combustion, and which gave, when compared with my crucible steel standard colouration, results fully one-sixth too low. After a number of experiments with different samples of crucible and Bessemer steel of various tempers, by carefully observing the phenomena when the cold nitric acid was added to the steel drillings, and by numerous check estimations by combustion or chromic acid oxidation, I became convinced that carbon was capable of existing in steel in different conditions, and that steel containing the same percentage of carbon might give, when dissolved in nitric acid, a greater or less degree of colouration, according as the carbon was in one condition or another. Fortunately also I was able to apply a method of correction, which, although entailing additional trouble, rendered the process in all ordinary cases susceptible of a high degree of accuracy.

In most samples of Bessemer steel containing over 0·60 per cent of carbon taken from the ingot, the carbon exists in a form agreeing with the sample received from Mr. Allen, already alluded to; while, on the other hand, most samples of crucible steel contain it in a form which gives a higher colouration for the same amount of carbon—nearly in the ratio of 6 to 5. If to a decigramme of each of two such steels containing a similar percentage of carbon, an equal amount of nitric acid be added, the difference of appearance as they dissolve side by side is most striking. In the first case the colour of the liquid while the first rapid action is proceeding appears of an orange-*yellow*; in the second a dark Vandyke-*brown*, sometimes approaching black; and when the effervescence has subsided, the appearance of the residue, as yet undissolved, is equally distinctive—consisting, in the first case, almost entirely of small skeletons, retaining the shape of the fragments of steel from which they are derived, while, in the second, it is entirely of a light flocculent character, and very much darker in colour than the former. For the sake of simplicity I shall call the first the "yellow," the second the "brown" form of carbon. Were there only these two extremes there would be no difficulty about the matter; but any grade intermediate between the two may occur, and in rare cases even greater differences are noticeable. The following are examples of the difference in colouration results obtained in a few typical samples:—

By colouration ..	0·88	By chromic acid ..	0·873
" " ..	0·73	" " ..	0·733
" " ..	0·61	" " ..	0·615
" " ..	0·605	" " ..	0·595

In the above the carbon appeared in the "yellow" form, as was the case with the standard used throughout; but in the following samples it was in the "brown" form.

By colouration ..	1·26 (1·05)	By chromic acid ..	1·059
" " ..	0·95 (0·79)	" " ..	0·773
" " ..	0·875 (0·73)	" " ..	0·695

The figures in parentheses are obtained by deducting one-sixth from the figures given by colour test, and it will be noticed that in the last case an even greater deduction is required to obtain the true amount of carbon: so again, in a few cases a slight addition is necessary to the result obtained from the standard here employed, which does not represent quite the extreme limit of "yellow"ness. Taking the two most extreme points I have hitherto met with in actual practice (the steel being unworked, hammered, or rolled, but *not* hardened), the ratio of colour obtained from the same amount of carbon would be nearly as 3 to 4; but with very rare exceptions the variation does not exceed the limit of 5 to 6. By very careful observation of the indications when dissolving, followed by numerous check tests by gravimetric analysis, I was able to work out a scale of fractional additions and subtractions, by the application of which I was enabled to obtain results of a high degree of accuracy. This system I have employed during nearly two and a half years with most satisfactory results, and only when a high percentage of carbon is indicated from which a large deduction has to be made do I feel any hesitation in fully relying upon the exactness of the estimation thus obtained. It is impossible of course by mere description to enable other workers

to apply such a scale; each observer must work one out for himself. This will require time and trouble, and its application considerably complicates the colouration process, but such a system is absolutely necessary if reliable results are required.

The carbon from the same piece of steel may be readily changed from the one modification to the other. If, for instance, an ingot of hard Bessemer steel, with its carbon in the "yellow" condition, be strongly heated and allowed to cool slowly, it will generally be more or less completely converted into the "brown" form; by the uncorrected colouration method it would appear to contain a higher percentage of carbon than before, but apply combustion and its amount will be found to be unaltered (except, of course, near the surface, where it may be sensibly diminished owing to superficial oxidation in the heating). On the other hand, a steel containing carbon in the "brown" form, if hardened, even though subsequently annealed so as to admit of drilling, will probably have it converted into the "yellow"; judging by the uncorrected colouration results the percentage of carbon would appear to have diminished, although the same amount is still actually present. As steel when hardened cannot be filed or drilled, no method occurred to me for a long time by which I could test quantitatively the effect upon the colouration results of the change in condition of carbon which takes place on hardening. The following device, however, enabled me to obtain satisfactory results. Drillings of steel, not too large to be subsequently dissolved in nitric acid for the colouration test, were closely packed in the fine powder from the same sample, and tightly wrapped up in platinum foil. The whole was then heated to a bright red and plunged into cold water. Although where air had penetrated the usual dark blue temper colour was shown, a large portion of the sample was so effectually protected from even superficial oxidation as to retain its original colour and lustre. The sample was immediately pressed between blotting-paper, and thoroughly dried in the water-bath. Fragments were then carefully picked out which retained their metallic lustre and natural colour (or at most a faint straw), and a decigramme was dissolved in nitric acid in the usual way. The first sample operated upon contained its carbon nearly in the brown condition, and the result of hardening was to convert it into the extreme yellow form.

By colouration—

Unhardened steel..	1·00	Actual carbon..	0·86
Hardened ,, ..	0·815		

But when I operated in a similar manner upon steel containing its carbon already in the "yellow" condition, I found that the colouration results after hardening were still nearly one-fifth lower (*e.g.*, 0·74 and 0 60 respectively), the carbon being evidently further modified in the same direction. In this case the colour of the solution, after action of cold nitric acid, appeared of a peculiar deep orange colour, while, instead of the very decided skeletons left undissolved in the unhardened sample, nearly the whole went into solution before heating, the very minute residue consisting of a few diminutive orange filaments. It is fortunately impossible to drill hardened steel, so that in practice one has not to contend against this further distinction; steel which is to be tested by the colouration process should never be hardened, as even if subsequently annealed I consider the results so obtained untrustworthy.

The action of nitric acid upon steel, although the most conclusive, is not the only proof that there is a real difference in condition of the carbon in various samples. Many observers had previously noticed that hydrochloric acid acts in a different manner upon steel in the hardened and unhardened state,* their results being well summarised by Prof. Akerman (*Journal of the Iron and Steel Institute*, 1879, pp. 504-6) who remarks:—"It thus appears that the carbon commonly called combined ought properly to be divided into two kinds, viz., first the carbon most intimately combined with the iron, which we, in accordance with Rinman's proposal, shall call *hardening carbon*, inasmuch as it characterises the well hardened steel; and, further, the carbon incompletely combined with the iron, which may be said to be in a sort of passage to graphite, and which Rinman called *cement carbon*, because it occurs in largest proportion in the undrawn blister or cement steel."

I have found, moreover, that when the steels have been treated with cupric salts (as a preliminary to combustion) the residue of carbon, &c., left undissolved, presents a totally different appearance, according as the carbon existed in the "brown" or "yellow" form. In the former case it remains as a powder in an extremely fine state of division, with a great tendency to penetrate through the asbestos filter when washed; in the latter it is much more bulky, and apparently consists of porous carbonaceous skeletons of the original drillings of steel.

What is the exact nature of the difference in condition of the carbon which gives rise to these various phenomena? It is because I have as yet been unable satisfactorily to solve this problem that I have so long delayed publication of my observations. The carbon in white cast-iron and steel is usually spoken of as "combined." Mr. Snelus considers that it rather exists in a state of solution. Now experiments made by MM. Troost and Hautefeuille showed that a pure white carburetted cast-iron gave a greater amount of heat when treated with mercuric chloride in the calorimeter than pure iron itself; hence the absorption of the carbon by the iron had been accompanied by absorption of heat, and its condition was physically analogous to a state of solution. But a carbide of iron and manganese, on the other hand, gave very much less evolution of heat with mercuric chloride, and indicated the existence of a true *compound* of carbon and metal. Is it not then possible that in what I have called the brown form the carbon is in a state physically analogous to solution, whereas in the yellow form it is really chemically combined with the iron? This appears to me the most probable explanation. As yet, however, it is only conjectural; but I intend shortly to examine microscopically the etched polished surfaces of a series of specimens I have been collecting containing the carbon in extreme forms, a method of investigation which I hope may enable me to solve the problem, or at any rate throw considerable light upon the subject. I thought it right, however, without further delay to draw the attention of chemists to a source of variation in the colouration process, which, if not duly corrected, most seriously affects its accuracy, a source of error which so far as I can ascertain has hitherto escaped detection.

* I may take this opportunity of remarking that the statement so frequently reproduced that unhardened steel contains *graphite* which passes into the combined state on hardening is quite erroneous. I have never observed true graphite in the enormous numbers of hard steels which have passed through my hands, and I have made special search for it by treating large quantities of highly carburetted crucible steel with hydrochloric acid, but always with negative results.

VOLUMETRIC DETERMINATION OF LEAD.

By W. DIEHL.

The author employs a 1-20th normal solution of potassium bichromate containing 7·38 grms. per litre, each c.c. representing 0·01035 grm. lead, and a solution of sodium hyposulphite, containing 4 to 5 grms. per litre. To determine the relations between these two solutions, 20 to 30 c.c. of the bichromate are run into a flask, diluted with 300 c.c. water, and mixed with 20 to 25 dilute sulphuric acid (1 vol. monohydrated acid and 2 vols. of water). A certain excess of sulphuric acid is indispensable, hydrochloric acid being less convenient. The liquid is brought to a boil, and the solution of hyposulphite is added drop by drop. The solution becomes gradually paler in colour. Towards the end, after the addition of a few drops, it is let boil up again. The end of the reaction may generally be distinguished by the liquid turning perfectly colourless,

a result occasioned by a single drop. In order to judge of the colour, the flask, towards the end of the operation, may be set in a porcelain capsule. When very large quantities of bichromate are used the liquid does not become perfectly colourless, but slightly greenish.

In determining ores in this manner they are dissolved in *aqua regia* and dilute sulphuric acid, the solution concentrated till the sulphuric acid begins to evaporate, diluted with water, boiled to dissolve ferric sulphate, let cool, and filtered through a smooth filter, washing with water containing sulphuric acid. To the residue in the flask—as little as possible of which is thrown upon the filter—is added about 15 c.c. of a solution of neutral ammonium acetate, and about 50 c.c. of water. The whole is then boiled, and filtered through the same filter into which a drop of ammonia has been put, into a flask. The same operation is then repeated with 5 c.c. ammonium acetate, and the residue is finally well washed with boiling water to which a little of the same salt has been added. Thorough washing is necessary, since filters have been found to retain ammonium lead acetate and tartrate with considerable obstinacy. It is then advisable further to wash the filter from its margin downwards with a little boiling dilute hydrochloric acid (1 part hydrochloric acid at sp. gr. 1·12 with 10 parts of water), and then to wash again with hot water. In this manner every trace of lead is removed from the filter. A thin filter-paper should be used, and should be washed previously. The solution of lead sulphate in ammonium tartrate thus obtained is then titrated in the cold with potassium bichromate; with the aid of heat ammonium acetate dissolves a little lead chromate. The precipitate settles readily if the flask is shaken, and the end of the reaction can be observed to within 0·2 to 0·4 c.c.

An excess of at least 2 c.c. of the chromate solution should be added in order to obviate the solubility of the lead salt. It is advisable in every experiment to take as closely as possible an equal quantity. After thoroughly shaking, it is allowed to stand for half an hour and filtered. If the liquid passes through turbid, a few drops of a solution of sodium acetate acidulated with acetic acid are added. If, after all, a little lead chromate passes through the filter, the filtration is repeated. The precipitate is washed four times with cold water, and the solution is acidulated with sulphuric acid and titrated as above.

Ammonium acetate is preferable to all other ammonium salts as a solvent for lead sulphate. It is applied in a neutral or faintly acid state. Free ammonia renders the solution turbid. 1 grm. lead sulphate requires 15 c.c. of the liquid acetate for solution. Ammonium tartrate cannot be used.—*Zeitschrift für Analyt. Chemie.*

FURTHER COMMUNICATIONS ON THE REVERSION OF FERRIFEROUS AND ALUMINIFEROUS SUPERPHOSPHATES.

By Dr. C. F. MEYER.

CONTINUED investigations on the reversion of superphosphates containing iron and alumina have shown the author that the conclusions drawn from his former observations are incorrect. If a concentrated solution of monobasic calcium phosphate is mixed with neutral ferric sulphate, an abundant precipitate of calcium sulphate is determined. This precipitate is formed slowly and is much impeded by the presence of free acids, so as to escape observation in the author's first experiments. Hence he assumed that the double decomposition of monobasic calcium phosphate and ferric sulphate must be preceded by a conversion of the former into bibasic calcium phosphate, with separation of phosphoric acid, effected by the application of heat or by diluting the solution. Hence, he concluded, that in superphosphates, monobasic calcium phosphate must first form a bibasic salt by the reaction of the tribasic salt before the double decomposition with ferric sulphate can take place. This assumption is incorrect, since monobasic calcium phosphate and ferric sulphate very soon form gypsum and acid iron phosphate, and the reversion of superphosphates is therefore due to the action of this acid phosphate upon other constituents of the superphosphate. It was therefore of importance to acertain whether acid iron phosphate reacts upon tribasic calcium phosphate in such a manner as to explain the reversion, or if a reaction of the acid iron phosphate upon other constituents of the superphosphate must be taken into account. If the action of the acid iron phosphate upon tribasic calcium phosphate is of such a nature that two molecules of the former withdraw two atoms of calcium from one molecule of tribasic calcium phosphate, the transformation of monobasic calcium phospate with ferric sulphate into gypsum and acid iron phospate, and the action of the latter upon tribasic calcium phosphate, will be unattended by a loss of soluble phosphoric acid.

It seemed more probable that acid iron phosphate withdraws only one atom of calcium from tribasic calcium phosphate, and that thereby a third part of the phosphoric acid, which was originally dissolved, is rendered insoluble. For the decision of this question, the following experiments were performed:—

1. To 6 c.c. phosphoric acid, containing 1·42 grms. P_2O_5, iron phosphate was added till a portion remained undissolved. To this solution were added 5 grms. tribasic calcium posphate, and after thorough stirring the mass was let stand for half an hour. The analysis showed 1·44 grms. phosphoric anhydride soluble in water.

2. The first experiment was modified in such a manner that only 2 grms. iron phosphate were employed, the other proportions being unaltered. (For the formation of acid iron phosphate, 1·88 grms. of the iron phosphate employed were required.) The analysis showed 1·56 grms. P_2O_5, against 1·42.

3. 1 grm. neutral iron phosphate was used, the proportions being otherwise similar. The result was 1·80 P_2O_5, in place of 1·42.

These experiments support the view just expressed, that acid iron phosphate withdraws from tribasic calcium phosphate only 1 atom of calcium, and thereby renders a third of the dissolved phosphoric acid insoluble; for in case of an action of 2 molecules acid iron phosphate upon 1 molecule tribasic calcium phosphate, the above experiment should have yielded 2·13 grms. P_2O_5 soluble in water. The author does not consider this action of the acid iron phosphate dependent on a modification of the acid properties of the phosphoric acid, but on the circumstance that after the first action of the acid phosphate upon tribasic calcium phosphate, neutral iron phosphate separates out, which coats the bibasic calcium phosphate and protects it against a further action of the phosphoric acid.

The result of this investigation may be thus briefly summed up: by the reaction of ferric sulphate upon monobasic calcium phosphate, there is formed an acid iron phosphate, and by its action upon tribasic calcium phosphate about one-third of the soluble phosphoric acid is rendered insoluble. By this process, the reversion of the ferriferous and aluminiferous superphosphates can be explained. It is still possible, however, that the acid iron phosphate may also react upon other ingredients of the manure, and that thereby the reversion of the phosphoric acid may be promoted and increased.—*Zeitschrift f. Analyt. Chemie.*

The Chemical Society.—We are happy to state that the Worshipful Company of Drapers have intimated their intention of continuing, at all events for the present, their annual subscription of 100 guineas to the Research Fund of the Chemical Society.

CONTRIBUTIONS TO THE CHEMISTRY OF BAST FIBRES.*

By E. J. BEVAN and C. F. CROSS.

(Concluded from page 80.)

Our attention is now called to the results of such an investigation of the character and constitution of the bodies associated with the celluloid basis of the jute fibre. Their relations to its structure are essential, for with their removal the continuity of the fibre is dissolved *pari passu*, until when completely removed it is resolved into a mass of its minute ultimate elements. Not only is this the case, but its remarkable affinity for colouring matters is entirely conditioned by the same group of substances.

Both of these important characteristics are demonstrated by the specimens on the table, showing the gradual loss of continuity and of dyeing capacity as we proceed from the raw fibre to the pure cellulose. The distribution of the intercellular body is remarkably uniform throughout the fibre. On the table are specimens of entire lengths treated in one case with a solution of aniline sulphate, which colours this fibre constituent a bright yellow, and in the other with a hot solution of an aniline-blue. The perfect uniformity of colour throughout in each case is an index of the corresponding distribution of intercellular matters, and this is fully corroborated by determinations of the percentage of carbon in the fibre at different points in its length. The technical bearings of these properties are clearly very important. They are essential conditions of the interesting developments which are now being made in the applications of the fibre, and at the same time serve to place it on the limits of the possibility of such textile application; moreover, they explain its typical character and peculiar fitness to serve as the medium through which to approach the chemistry of bast fibres generally.

The action of chlorine, which we have already witnessed, shall be our first pioneer. It is accompanied by a change of colour to bright orange, a marked evolution of heat, and the formation of a body soluble in alcohol and in glacial acetic acid. On throwing either solution into water we observe a copious precipitation of a flocculent resinous substance.

Our investigation of this body has shown it to be a definite compound. The following analytical results will prove this. (The compound was previously dried at 100°):—

I.

Chlorine—0·6145 gave 0·6575 AgCl + 0·0068 Ag

Combustions (in stream of oxygen with usual precautions).

(*a*) 0·2645 gave 0·4115 CO_2 and 0·83 H_2O
(*b*) 0·3645 ,, 0·579 ,, ,, 0·1115 H_2O
(*c*) 0·3385 ,, 0·5305 ,, ,, 0·1015 ,,

	(*a*)	(*b*)	(*c*)
C	42·42	43·32	42·74
H	3·48	3·40	3·33

	Mean.	Calc. $C_{19}H_{18}Cl_4O_9$.
C	42·82	42·85
H	3·40	3·38
Cl	26·83	26·69

II. The product was then dissolved in glacial acetic acid, precipitated by water, washed, and dried; then dissolved in alcohol, precipitated by water, washed, dried, and analysed:—

Chlorine .. .. 0·2755 gave 0·2895 AgCl + 0·0072 Ag
Combustion .. 0·336 ,, 0·5295 CO_2 and 0·105 H_2O

C	42·97
H	3·48
Cl	26·82

III. A fresh specimen of jute was chlorinated and the product isolated as before. It was then exposed to an atmosphere of chlorine for some hours, purified, and analysed.

Chlorine .. .. 0·721 gave 0·7705 AgCl and 0·0082 Ag
Combustion .. 0·2923 ,, 0·4625 CO_2 and 0·09 H_2O

C	42·99
H	3·40
Cl	26·81

IV. A specimen of jute was chlorinated after exposure for some hours to the action of sulphuric acid (5 per cent) at 60° to 80°. (This latter will be discussed from another point of view hereafter.) The product was further treated as in III.

Chlorine (*a*) 0·3045 yielded 0·324 AgCl + 0·008 Ag (27·25 per cent).
(*b*) 0·3038 yielded 0·3312 AgCl + 0·0056 Ag (27·15 per cent).

Combustion—0·299 gave 0·4675 CO_2 and 0·095 H_2O.

C	42·64
H	3·52
Cl	27·2

These results sufficiently establish the definite nature of this body. The formula by which the numerical results in respect of the ratio of the elements are expressed shows the general agreement, which might be anticipated, with the interesting, but as yet unclassified, group of plant constituents, of which we may mention xantho-rhamnin, $C_{23}H_{24}O_{14}$, luteolin, $C_{20}H_{14}O_8$, rubian, $C_{28}H_{34}O_{15}$, aloine, $C_{17}H_{18}O_7$.

The presence of 4 atoms of chlorine is again in harmony with the tendency to form tetra substitution products which characterises certain of these bodies.

The reactions of this body are quite as striking as its composition. We have already mentioned its solubility in alcohol and glacial acetic acid; it is, further, slightly soluble in water. It is dissolved by concentrated sulphuric acid without separation of carbon, but is not re-precipitated on dilution. All these solutions possess the characteristic smell of tetrachloroquinone. Moreover, they are coloured violet on addition of ammonia, similarly to chloranil. Bearing in mind the presence of Cl_4 in the molecule of both, and a number of *a priori* considerations which will suggest themselves to those who have worked at vegetable chemistry, there is ground for regarding this chlorine derivative, or rather the body from which it is obtained, as a quinone.

But we have yet to demonstrate its most striking reaction. Plunging this piece of the chlorinated fibre into a solution of sodium sulphite, the orange-yellow slowly gives place to a magnificent magenta of great purity. This reaction is suggestive of very much that remains to be investigated: being but a recent observation we must content ourselves at present with this bare fact. We may, however, mention that it is a valuable point in the diagnosis of the chemical characteristics of fibres; it is observable with the encrusting matters of other bast fibres, flax, hemp, nettle, &c., in which they are present in far too small quantity to allow of quantitative investigations such as the jute fibre permits. Hence by means of our type we are enabled to infer the general chemical identity of bast fibre constituents.

The technological application of the reaction in the identification of bast in paper and textile fabrics we need not dwell upon.

We turn to consider a branch of this portion of our subject which establishes still further the general character of the previous results.

The material known as Esparto, so largely used by the paper manufacturer, consists of the leaves of a species of grass (*Macrochloa tenacissima*). In this case, therefore, we are dealing with a monocotyledonous plant. The first process to which it is subjected in the paper factory is that of heating under pressure with a solution of caustic soda. The brown liquors obtained in this way yield, when neu-

* Read before the Owens College Chemical Society, April 16, 1880.

tralised, a fine flocculent precipitate. This we collected, purified by dissolving in glacial acetic acid, and precipitating by the addition of water, repeating this process once or twice, obtaining finally a brownish black resinous body, free from silica, and from a fatty acid (wax),* originally present in some quantity, and having the following ultimate composition :—

			Calc. $C_{21}H_{24}O_8$.
C	61·5 per cent	C	62·37
H	5·86 ,,	H	5·94
(N	1·2) ,,		

This body was chlorinated by the action of potassium chlorate and hydrochloric acid: the product was purified by solution in acetic acid and precipitation by dilution with water. After repeating this process once or twice, the product was washed, dried, and analysed :—

Chlorine (*a*) 0·336 gave 0·314 AgCl+0·0046 Ag (23·54 per cent).

(*b*) After further exposure to chlorine gas, and subsequent purification, 0·264 gave 0·2455 AgCl+0·0096 Ag (24·16 per cent).

Combustion—0·2768 gave 0·455 CO_2 and 0·096 H_2O.

		Calc. $C_{22}H_{23}Cl_4O_{10}$.
C	44·79	44·2
H	3·83	3·9
Cl	23·8	24·1

This body is not to be distinguished, qualitatively, from the chlorine product from jute ; its composition, moreover, is closely similar, the ratio C : H : O being practically the same, and four Cl atoms appearing in the formula. It is to be observed that, though formed under different conditions, both as regards previous preparation, chlorination, and oxidation, and, further, derived from a plant of very different botanical characteristics, it yet exhibits all the essential features of the chlorine body previously described ; and we may therefore predicate of these natural quinones conformity to a general type, considerable stability, and wide diffusion in plant structures. The bromine derivatives of these bodies we have not yet been able to investigate quantitatively: the qualitative resemblance to the chlorine products is extremely close. In concluding this part of our subject, we would mention that the presence of these quinone-like bodies in solution—as, for instance, in alkaline liquids in which vegetable matters have been boiled—is easily ascertained by adding bromine water (after previously acidifying), which precipitates the brominated compounds in yellow flocks. On bringing them in contact with ammonia, which may be added without filtering, the characteristic bright purple colouration is developed.

The next division of our subject is connected with the preceding by the observation that on exhausting the ichlorinated jute fibre with water there is dissolved, in addition to a small quantity of the chloro body, a substance which reduces Fehling's solution. The quantity of CuO reduced was determined in two instances, with the following results :—

(*a*) 0·3582 grm. jute. Washings after chlorination reduced, 0·1555 grm. CuO.

(*b*) 3·693 grms. jute. Washings ditto, 0·1607 grm. CuO.

which show that this body must be present in some quantity. Two questions at once present themselves touching its identity. Is it a sugar? Is it metapeptic acid? To these probable *a priori* solutions we must give an answer. We will not ask you, however, to follow us through all the steps of an argument which has exacted many months of work, and is still in progress, though shortly, we hope, to be completed. The latter probability entailed much work, leading only to negative results, through finding a paper of Kolb's in the *Bull. Soc. Ind. Mulhouse*, June, 1868, in which he claims to have established the presence of pectose in the linen fibre. Guided by this light we have searched closely for members of this group of bodies, of which pectose is the first member, amongst the products of decomposition of the intercellular substance of bast, but as yet with no results. The decompositions of the jute fibre to which we look for the satisfactory solution of this problem are the action of dilute acids and alkalies, and a curious decay or fermentation which is induced under certain conditions.

(1) *Action of Acids.*—By the action of sulphuric acid (5 per cent) at 60° to 80° a remarkable change is wrought in the fibre: the colour is changed from silver-grey to dark brown, the fibre is entirely disintegrated, becoming at the same time so brittle that it may be rubbed in a mortar to a fine powder. (It is a remarkable circumstance that the fracture of the fibre, which is thus brought about, takes place across the whole bundle of ultimate fibres, the union of these into bundles being unaffected by the acid.) But the most important result is the formation and solution of a body reducing Fehling's solution. This occurs at a temperature as low as 50° to 60°, but much more abundantly at 80° to 90°. To isolate the body formed, the solution was neutralised with chalk, filtered from calcium sulphate, and precipitated in fractions by basic lead acetate. These precipitates were decomposed by sulphuric acid, filtered, and the solutions digested on barium carbonate. On filtering and adding to a portion of the filtrate an equal volume of alcohol no precipitation occurred ; the absence of metapectic acid was therefore established. The filtrates were severally evaporated to dryness ; the residue was in each case dark coloured, viscous when hot, but becoming brittle on cooling. It was broken up and exhausted with alcohol ; a large proportion of the mass was dissolved ; the solution was filtered, and after distilling the alcohol a viscous body was obtained, brown-coloured, smelling strongly of burnt sugar, containing 2·6 per cent of ash constituents, but no trace of barium. We have made analyses of this body, with the following results :—

* (*a*) 0·292 gave 0·155 H_2O+0·5075 CO_2
(*b*) 0·3322 ,, 0·178 H_2O+0·5615 CO_2

	(*a*)	(*b*)	Calc. $C_{12}H_{18}O_9$.
C	46·29	46·08	47·05
H	5·75	5·95	5·88

* Deducting ash.

The formula to which these numbers approximate is that of caramel ; but as the product is still under investigation we defer any final statement as to its composition. Still there can be little doubt that it is a carbohydrate, and it is certainly a neutral body. To what portion of the fibre does it owe its origin ? On this point we submit the following results :—

A specimen of raw jute digested with the dilute acid for forty-two hours at 60° to 90° lost 23 per cent in weight. Two specimens of the same portion of fibre, after undergoing the same treatment, were treated by Müller's method for the isolation of the cellulose, and they were found to yield 58·9 and 57·9 per cent respectively (we have a number of similar determinations giving identical results, but these it is unnecessary to detail). As the quantity of "aggregate" cellulose obtained directly from the raw fibre, by the same method, was 70 to 71 per cent, 12 per cent of the loss sustained under the acid treatment is accounted for, *i.e.*, is due to the conversion of a portion of the cellulose itself into a soluble modification. Direct experiments on cellulose supported this conclusion. We append the results of a comparative investigation of this point :—

(*a*) Digested 18 hours at 60°—80° with 7 per cent H_2SO_4.
(*b*) ,, 16 ,, ,, ,, ,, ,,
(*c*) ,, 12 ,, 80°—90° ,, ,,

* A specimen of this wax, after purification, was found to contain—

		Calc. $C_{17}H_{34}O_2$.	
C	75·38	C	75·5
H	12·3	H	12·5

	Loss per cent. (a)	(b)	(c)
Rhea (China grass), cellulose ..	2·8	—	—
Cotton	2·7	3·6	—
Jute	12·0	(1) 8·4	(1) 9·9
		(2) 6·8	(2) 9·5

The cellulose in each case underwent a structural modification similar to that which we have described in the case of the raw jute fibre, *i.e.*, it was entirely disintegrated, breaking up under pressure, with a brittle fracture, into a fine powder. An investigation of the acid solution after digestion upon the raw fibre shows that traces only of the aromatic constituents of the fibre have been dissolved; so also after prolonged digestion at 110° in a sealed tube. Moreover, it will be remembered that on chlorinating the fibre after the action of the acid a product was isolated identical with that obtained from the normal fibre. The modifying action of sulphuric and hydrochloric acids we regard, then, as chiefly confined to the carbo-hydrate constituents of the fibre. But, reverting for a moment to the numbers expressing the loss of weight by the raw fibre under the action of the acid (25 per cent), and a consequent diminution of 12 per cent in the yield of cellulose, the residual 11 per cent, if a carbo-hydrate, must have been originally present in what we have termed the intercellular substance. Can this be of the nature of the glucosides? That a quinone should be associated with a sugar is by no means improbable—the chemistry of the madder root affords a typical instance of such a union; but that the integrity of the jute fibre should be bound up with that of a glucoside is a hypothesis which its practical stability tends to negative. (2) There is nevertheless an interesting species of *fermentation*, a case of which has recently come under our notice, which takes place when masses of jute are allowed to lie in the damp state, in consequence of which the fibre undergoes a similar dissolution to that which is induced by hot dilute acids, and which, together with what has gone before, will, we think, eventually lead to an adoption of a modification of the glucoside hypothesis as representing the actual chemical condition of the intercellular body. In examining a specimen of jute which had become entirely disintegrated in consequence of this fermentation, we found that it contained as much as 10 per cent of matter soluble in water, made up of both aromatic and carbohydrate bodies, the solution reducing CuO copiously. On exhausting with a boiling solution of caustic soda (1 per cent) as much as 23 per cent of the weight of the fibre was removed in solution. Further, the percentage of cellulose determined by Müller's method, was found in two specimens to be 60·4 and 58·8 respectively. The decomposition which had taken place resembled, therefore, that which is effected by hot dilute acids in every particular, with the exception that in the latter case traces only of the aromatic constituent are rendered soluble. Not having yet completed the more special investigation of the products of this natural resolution of the intercellular substance, we can apply it in this discussion only in its general features; these are such as to indicate an intimate association of the aromatic constituent with some carbohydrate. This view is still further supported (3) by a study of the *action of alkalies* on the fibre. The loss of weight experienced by the fibre when treated with a solution of caustic soda of course varies with its strength and temperature, and the duration of its action. A cold solution (1 per cent) removes 1 to 4 per cent: with boiling solutions the following results have been obtained:—

Loss of Weight.	Duration of Boiling.	Strength of Solution.
6 per cent	5 minutes	1 per cent
7·5 ,,	1 hour	1 ,,
8·7 ,,	4 hours	1 ,,
12·8 ,,	10 minutes	5 ,,
12·8 ,,	1 hour	5 ,,
14·6 ,,	5 hours	5 ,,

The solutions acquire a brown tint. On neutralising with an acid they give a flocculent precipitate soluble in alcohol, and therefore not pectic acid, which, moreover, on treatment with chlorine and sodium sulphite gives the reaction characteristic of the aromatic constituent. The quantity of this dissolved does not, however, appear to be large. The alkaline liquid does not reduce CuO directly, but after acidifying and boiling a copious reduction occurs. This is additional evidence of the existence of a carbohydrate in the fibre other than the more stable modification of cellulose. We will briefly summarise the points of this discussion before passing to the conclusion which is to be drawn from them.

(*a*) Chlorination of the aromatic constituent is accompanied by liberation of a body which reduces CuO, which does not decompose $BaCO_3$, and which is soluble in absolute alcohol.

(*b*) After the re-solution of the intercellular basis of the fibre by fermentation, water removes a soluble modification of the aromatic constituent together with a body reducing CuO.

(*c*) By the action of the dilute mineral acids (HCl, H_2SO_4), the fibre is disintegrated as in (*b*), and there is dissolved a carbohydrate resembling caramel in its properties, and having nearly the same percentage composition. The formation of this body occurs as low as 60° C., and takes place copiously at 80° to 90°; it cannot, therefore, be formed from cellulose as ordinarily understood. The examination of the acid solution, after digesting upon the fibre, by means of fractional precipitation, showed the presence of an aromatic body in small quantity (first ppt.), but with this exception, of carbohydrate products only.

(*d*) Under the action of boiling dilute alkalies the aromatic constituent is dissolved to some extent, and at the same time a body which, after boiling with a dilute mineral acid, reduces CuO.

(*e*) The average of our determinations of carbon in the raw fibre is 46·5 per cent. From the examination of the resinous body obtained from the intercellular substance of the Esparto fibre, and comparison of the chlorine product which it yields with that obtained from jute, it is evident that the formula of the aromatic constituent of the latter must approximate to $C_{20}H_{23}O_9$. Now the percentage of isolable cellulose in the fibre is 70—75; if the residual 30—25 per cent were entirely aromatic, the percentage of carbon should be at least 49. Finding that it is less than this by 2·5 per cent, and also that the re-solution of this portion of the fibre is attended by the formation of a body having the properties of a carbohydrate, the source of this product is, we conclude, first, a body of comparatively low carbon percentage, and secondly, a carbohydrate.

(*f*) The cellulose obtained from the fibre, by the action of halogens and alkalies, is not chemically homogeneous; moreover, the percentage yield varies with the several methods by which the intercellular substances may be removed. We have, therefore, as before stated, reason for believing them to contain a body allied to cellulose. These facts are explained by the hypothesis that the intercellular substance consists of a complicated quinone which is intimately associated with a carbohydrate. The stability of this union, in consequence of which it is only slowly acted upon by boiling acids, even resisting to a large extent the prolonged action of 5 per cent H_2SO_4 at 110° (for on subsequent chlorination a fresh quantity of the body which reduces CuO is liberated), is explained by the supposition that the carbohydrate is more closely allied to cellulose than to glucose. There are, moreover, evident *a priori* grounds for believing in the existence of a group of *cellulides* analogous to the glucosides, of which *cellulo-quinones* would be a subdivision; and the evidence afforded by our investigation leads us to such a view of the constitution of the intercellular substance of bast fibres. The results of the technical application of our researches to the treatment of jute for the production of the beautiful fabric called Kalameit are singularly in harmony with this view. To enable this fibre to withstand the oxi-

dising action of the colour-mixtures, and of the superheated steam (105°) employed by the printer will suggest itself as a somewhat curious problem. That this can and has deen done the specimens on the table will show. As, however, the process is kept strictly secret we are not in a position to lay before you the additional evidence which it affords. Assuming that our hypothesis, as far as it goes, is confirmed by the further issues of our investigations, we doubt not that it will need to be considerably extended before it embraces the whole truth. For in addition to the observations forming the subject of what has gone before, there are others which we have made and not yet further investigated, and which cannot be explained by the knowledge we have thus far obtained. *E.g.*, (1) On boiling the fibre with water (or, better, dilute H_2SO_4) a small quantity of a solid body distils, resembling wax in appearance, and having the curious penetrating odour which is characteristic of ordinary jute goods. It is, moreover, highly probable that the distillate contains furfurol. To investigate these points it is our intention to operate with large quantities of material. (2) On exhausting the fibre, previously purified by boiling in ammonia, with hot alcohol, a bright green solution is obtained, resembling the alcoholic solution of chlorophyll. On evaporating the solution, small masses of a bright green resinous body are left, but the quantity is so minute (the loss of weight sustained by the fibre being scarcely perceptible) that we have not been able to submit it to further investigation. The spectroscopic examination of the solution we have had to defer.

With all the reservation, therefore, proper to inferences from work which is in progress, we are of opinion that the main portion of the intercellular substance of the jute fibre is a *celluloquinone*. Even should our future work fail to confirm this view, it has both given definiteness to our investigations and been productive of results; it therefore fulfils at least the demands of a good working hypothesis.

There still remains to bring before you the results of the study of the action of nitric acid on the constituents of fibres. The conversion of jute-cellulose into nitro-cellulose was undertaken for me by Mr. Brown, of the Government Gun-cotton Factory. He reported that it yielded a perfectly satisfactory nitro compound, but was not prepared to pronounce an opinion on the influence of its state of aggregation upon the combustibility of the product.

The action of the acid in dilute condition (5 per cent at 60° C.) upon the fibre is to effect the removal of the intercellular and encrusting matters, dissolving them to a bright yellow solution, which reduces Fehling's solution. We have several times attempted the separation of the products, but without success: we have therefore studied the action of the acid upon the resinous body obtained from Esparto, which we have shown to be closely similar to the aromatic portion of the jute intercellular; and as regards the carbohydrate portion, we assume that it will undergo a similar modification by this acid (in the dilute form) as by the other mineral acids.

The resinous body ($C_{21}H_{24}O_8$) was heated with nitric acid (50 per cent) until it was entirely converted into soluble products. The solution was diluted and filtered from a brown resinous body thereby precipitated, and evaporated to a small bulk. On cooling, some quantity of oxalic acid crystallised: the solution was decanted, neutralised with lime, and after filtering precipitated by basic lead acetate. This was decomposed by sulphuric acid, and the solution, filtered from lead sulphate, was boiled with barium carbonate. On filtering from the excess of the latter, concentrating and adding alcohol, a bright yellow body was precipitated. This body, the barium compound of the chief product of the action of the nitric acid on the resin, was washed with alcohol; dissolved in water, and re-precipitated by alcohol. Carrying this out in five fractions, we found the percentage of barium invariable. They were united, and the process once more repeated. The compound, dried at 100°, was analysed, with the following results:—

Ba 0·428 gave 0·299 $BaSO_4$.
N 0·960 gave after ignition platino-chloride 0·0772 pt.

Combustions—

(*a*) 0·133 H_2O + (0·463 + 0·084*)CO_2 from 0·624
(*b*) 0·171 H_2O + (0·588 + 0·107*)CO_2 from 0·8044

	(*a*)	(*b*)	Calc. $C_{25}H_{31}NO_{25}Ba_4$.
C ..	23·91	23·58	C .. 23·20
H ..	2·36	2·36	H .. 2·40
Ba..		41·47	Ba .. 42·36
N ..		1·13	N .. 1·08

* Determined in ash.

The calcium compound was similarly prepared, and on analysis gave results in accordance with the above.

Ca (*a*) 0·339 gave 0·199 $CaSO_4$ (*b*) 0·235 gave 0·138 $CaSO_4$.
N 1·075 gave after ignition of platino-chloride 0·1101 pt.
CH 0·6735 gave (680 + 0·126) CO_2 + 0·213 H_2O.

	(*a*)	(*b*)	Calc. $C_{25}H_{21}NO_{25}Ca_4$.
Ca.. ..	17·25	17·27	17·67
N	1·42	—	1·54
C	32·63		33·14
H	3·50		3·42

The free acid is, after drying at 100°, a dark-coloured gummy body, easily soluble in water to a bright yellow solution, which is bitter to the taste and dyes animal fibres a rich gold. It is evidently an aromatic compound, and possesses the general features of the group of quinones, of which it is a derived member: but beyond this we have not yet been able to investigate it.

With this we conclude the account of our investigations. They are as yet exceedingly imperfect, as is also our handling of them in relation to the theoretical questions involved; but in endeavouring to lay them before you we feel that we have undergone a discipline which will bear fruit in our future efforts.

It only remains for us to say a few words upon the existing literature bearing upon our subject. A brief notice must here suffice; we reserve the critical discussion which it invites for a more suitable occasion.

To Dr. Müller's "Pflanzenfaser," an invaluable work, and the only one which gives a survey of the general chemistry of plant fibres, we are much indebted. To this chemist, also, we owe valuable suggestions as to the nature and manipulation of the products through which the chemistry of these fibres is to be studied. Amongst these we may mention the observation (unpublished) of the presence of a quinone in bast fibres.

On the special chemistry of the jute fibre nothing appears to have been published. Our attention has been directed by Prof. Schorlemmer to certain papers of Erdmann's in the *Ann. Chem. Pharm.* (138-1 and Sup. 5-223), on "The Stony Concretions of Pears," and "Glycolignose" a constituent of pine wood), in which the author arrives at conclusions somewhat similar to those which we have advanced in the case of jute. The researches of Fremy, Girard, and others (*Comptes Rendus*) on cellulose and its modifications; the observed cases of conversion of carbohydrates into members of the pectic group (Divers, *Journ. Chem. Soc.*, Schoonbroodt, *Bull. Soc. Chim.*, &c.), we are investigating in their special relations to our subject. Some years will probably elapse before we shall have made out the chemical characteristics of these structures with definiteness. It is needless to remind our fellow students of the deep interest attaching to our work, far more than compensating for the failures and difficulties which we have had in turn to encounter.

We desire to express our thanks to the Barrow Flax and Jute Company, Messrs. Cowan and Co., of Musselburgh, and Mr. Bonsor, of the China Grass Company, Wakefield, for the loan of specimens in illustration of this paper. Also to Dr. Forbes Watson for a quantity of Rhea, to which fibre we hope soon to be able to turn our attention.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 3, July 19, 1880.

Researches on the Organic Alkalies.—M. Berthelot.—The author has determined the formation-heat of such organic alkalies as are capable of becoming gaseous at common temperatures. He finds that if ammonia and trimethylamine are brought in contact with equal equivalents of dilute hydrochloric acid, one-third of the trimethylamine is displaced by ammonia with disengagement of heat, whilst reciprocally two-thirds of the ammonia are displaced by trimethylamine with absorption of heat.

Atmospheric Electricity.—M. Mascart.—There is only one minimum during the day, and one maximum, which is almost constant during a great part of the night; that is to say, a single diurnal period. The amplitude of the diurnal oscillation is notably slighter during the winter.

Alternating Currents and the Electromotor Force of the Electric Arc.—J. Joubert.—The resistance of the arc is very feeble; it varies with the temperature and diminishes when the temperature rises. The difference of the potential between the two charcoal points is due chiefly to an electromotor force independent of the intensity, and which may be valued at 30 volts. The two points act towards each other like the two electrodes of a galvanometer.

A New Air Thermometer.—A. Witz.—The description of this instrument does not admit of useful abridgment.

Certain Fluorised Compounds of Uranium with the Alkaline Metals.—A. Ditte.—The action of a neutral fluoride of the alkaline metals upon the green oxide of uranium gives beautiful insoluble and anhydrous crystals of the formula $U_2O_2F,2MF$; whilst the action of the acid fluoride of the same metals produces soluble, hydrated salts, the composition of which may be expressed by the formula $U_2OF_2,2MF,nHO$.

Atomic Weight and Principal Properties of Glucinum.—L. F. Nilson and O. Pettersson.—The authors give for the atomic weight of glucinum (O=7·98) 4·542 as the mean of four determinations, former experimentalists having made it from 4·6 to 4·9. If glucina is Gl_2O_3 the atomic weight of the metal will be 13·65, in which case the atomic heat becomes completely normal.

Certain Compounds belonging to the Group of the Creatines and Creatinines.—E. Duvillier.—The compounds described are α-oxy-butyro-cyamine, α-oxy-butyro-cyamidine, iso-oxy-valero-cyamine, and iso-oxy-valero-cyamidine.

Action of Ethyl-chloride upon the Ethyl-amines.—E. Duvillier and A. Buisine.—The action of ethyl-chloride upon ammonia, studied by Hofmann, and upon the ethyl-amines formed during that reaction, renders it possible to obtain the four ethylated bases in large quantity. The reaction is more regular than that of the methylic ethers upon ammonia and upon the resulting methyl-amines.

Action of Electrolysis upon Benzol.—A. Rénard.—The author has obtained a secondary glycol, $C_6H_6(OH)$, which he names iso-benzo-glycol. It is soluble in water, alcohol, and ether; melts at 171°, and sublimes, with decomposition at 200°. Its solution is reduced by cupro-potassic liquor.

A Peculiar Alteration of Butcher's Meat.—M. Poincaré.—The author in examining a series of meat, condemned at the abattoir of Nancy, has detected heterogeneous elements, which appear to him to be parasites not yet classified, and which he has figured and described. He considers that they present a certain analogy with gregarines, and asks whether they may not be one of the phases or metamorphoses of the tænioids, and if it is not through their mediation that raw beef gives rise to tænia in human subjects.

Biedermann's Central-Blatt für Agrikultur-Chemie. Part 4, April, 1880.

Influence of Forests upon Rain-fall and Attraction of Watery Vapour by Pine Trees.—M. Fautrat.—The atmospheric strata over forests, and especially over pine trees, is distinctly richer in watery vapour than are strata at the same elevation over the bare ground.

Behaviour of the Natural Soil and of the Plants Rooted in it towards Water.—Dr. G. Havenstein.—Not suitable for abstraction.

Action of Fallows.—The fluctuations of temperature are much greater in fallow-land than in fields under crop. The amount of moisture is higher in the former even if frequently turned over.

Manurial Experiments on Rye.—Prof. E. Heiden.—Nitrogen in the form of nitric acid, gave a much better result than in the form of ammonia.

Cultivation of the Yellow Lupin.—Dr. Ernst Wein·—The lupin, without receiving nitrogenous manure, is capable of producing a large amount of nitrogenous tissues.

Should Potatoes be Manured with Bone-dust?—Dr. Meyer.—The total yield of the crop was found to be increased.

Chemical Researches on Woody Papilionaceous Plants.—Prof. P. Fliche and Prof. L. Grandeau.—From analyses of the ash of the laburnum, furze, acacia, and *Sarothamus vulgaris*, the author finds that plants belonging to one and the same natural family, and growing on the same soil, may differ greatly both in the quantity and distribution of starch, the proportion of ash and of nitrogen. The laburnum, though preferring lime soils, does not show a decidedly greater proportion of lime than the acacia.

Free Tartaric acid in Wine.—Prof. J. Nessler and H. Wachter.—The authors consider that genuine wines do not contain uncombined tartaric acid.

Determination of the Fatty Matter of Milk in Dairies.—Dr. P. Vieth.—The author rejects the cremometer and recommends the lacto-butyrometer.

Experiment with Feser's Lactoscope.—Ph. du Roi.—The author, after a series of eighty comparative experiments, finds the results of the lactoscope too low. In 45 cases, the fat was given as too little by 1 per cent; in 2 cases by 1½ per cent or upwards; in 26 cases by 1½ to 1, and only in 9 cases did the deficiency fall below ½ per cent. Considerable differences were found when two operators examined the same sample.

Part 5, May, 1880.

Culture of the Sugar Beet.—A. Ladureau.—Taken from the *Annales Agronomiques*.

Nutritive Value of Acorns.—H. Czubata.—The proteine compounds are small in proportion, and the dry matter contains nearly one-half of woody fibre.

Digestibility of Oat-straw, Pea-straw, and Meadow-hay.—Prof. E. v. Wolff, Prof. W. v. Funke, and Dr. C. Kreuzhage.—The nutritive value of pea-straw appeared equal to that of clover-hay. Oat-straw is inferior both in the proportion of nutritive matter and in digestibility.

Some Investigations on Hay.—W. Dircks.—Analysis of Norwegian samples of hay.

Transformations of Starch and Glycogen by Diastase, the Ferments of the Pancreatic Saliva and of the Liver, as in the Animal Organism.—F. Musculus, J. von Mering, and E. H. Bimmermann.—Saliva and pancreatic ferment yield with starch the same products as diastase. With glycogen the same result is produced by

the same ferments. The action of diastase upon glycogen is less energetic than that of saliva. In the blood, soluble starch is transformed; among the products of decomposition, grape-sugar and dextrine were distinctly recognised in the urine. The presence of maltose was doubtful.

Formation of Albumen in Plants.—Dr. A. Emmerling.—It appears that the green leaves are especially the place where the nitric acid is converted into nitrogenous organic compounds. Ammoniacal salts play in comparison a subordinate part.

Beet-root Jelly.—Ph. von Tieghem.—Mention is made of a plant, *Lenconostoc mesenteroides*, which is developed in beet-root juice and inverts the sugar.

Culture Experiments with Varieties of Potatoes.—Dr. P. Wagner and Dr. W. Rohn.

Injury to Peas and Beans by the "Seed Beetle."—E. Wollny, A. Meyer, H. Grosjean, and Beal.—The insect in question is not named, but it is probably *Bruchus pisi*.

Sorghum Saccharatum.—Dr. A. v. Wachtel.—An account of the cultivation of sorghum in America and of some experiments tried with it in Bohemia.

Combustibility of Certain Kinds of Tobacco.—Prof. E. Quajat.—In the more combustible growths of tobacco, the potash salts predominate over the others. The proportion of nicotine had no influence.

Malto-dextrine.—Dr. A. Herzfeld.—The composition of malto-dextrin is $C_{18}H_{32}O_{16}$. It is capable of combustion and contains 12 acetyl groups to 18 atoms of carbon.

Methods of Determining the Dry Matter and the Fat in Milk, based upon Calculation.—Dr. Behrend, Dr. Morgen, F. Clausnitzer, and Prof. A. Meyer.—The two former chemists determine fat by the lacto-butyrometer, take the specific gravity, and find total solids by means of certain algebraic formulæ. The two latter authorities determine specific gravity and dry matter according to Schulze and Krämer's method and calculate the fat by a formula.

The "Stall-test" in the Supervision of Milk.—Ph. du Roi and Prof. Kirchner.—In prosecutions for the adulteration of milk, if a difference of opinion appears, the cow or cows alleged to have yielded the article are milked again in presence of an official, and the sample thus obtained is analysed by the same method as the first sample. If the second milk turns out decidedly better, it is considered evidence of adulteration.

Experiments on Skimming Milk by Swart's Process.—Dr. M. Schrodt.

A New Skimming Process.—Prof. Ad. Meyer.

Experiments with Levol's Separator.—Dr. N. Engström.

(The nature of these three papers appears sufficiently from the titles.)

On Condensed Milk.—Dr. E. Wein.—The author finds that, on account of the great proportion of sugar, the fat in such milks cannot be determined in the usual way. He stirs up 5 grms. of the condensed milk in a capsule with continually repeated doses of ether, which are rinsed into a flask through the same filter. He then adds to the milk sea-sand and extracts repeatedly with ether, breaking up the clots. The ethereal solution is evaporated to dryness, and the residue re-dissolved in ether to get rid of any milk sugar which may have been dissolved.

Experiments on Churning Milk and Cream.—Dr. M. Schrodt and Ph. du Roi.

Albumen of Milk and the Formation of Curd.—G. Musso and Cl. Menozzi.—The albumen present in milk is from 0·572 to 0·604 per cent. In composition it is almost completely identical with the albumen of blood. In its behaviour with precipitants it holds an intermediate place between blood albumen and casein. The acid required for the precipitation of casein decreases with the rise of temperature. At 130° to 150° no acid is required.

Preparation of Cheese, with Analyses of Danish Cheese for Exportation.—V. Storch.—The lower the temperature of coagulation the more watery is the curd.

Gluten Bread.—Prof. K. Birnbaum.—Results of the analysis of samples from Paris and Munich.

(We regret to learn from a notice inserted by the publisher, the death of Dr. Biedermann, the founder and editor of the *Central-Blatt*.)

Justus Liebig's Annalen der Chemie,
Band 202, Heft 3.

Phlobaphene, Oak-red, and Bark-tanning.—Dr. Carl Böttinger.—Phlobaphene and oak-red are identical. The substance, when isolated, is a reddish brown powder, insoluble in boiling water, cold alcohol, and boiling benzol; slightly soluble in boiling absolute alcohol; and tolerably soluble in a solution of the tannin of the oak, and in the aqueous solutions of the alkalies. By melting potassa, it is converted into protocatechuic acid and phloroglucine. In tannin with bark, phlobaphene is the true active principle, the tannin serving merely as a medium for its incorporation with the hide.

New Synthesis of the Acids of Carbon.—A. Geuther.—By the action of carbonic acid upon a mixture of sodium ethylate and sodium valerinate at 190°, there are formed, in addition to ketones, the following acids:—Ethyl-iso-propyl-acetic acid, ethyl-diethenyl-iso-propyl-acetic acid, ethyl-triethenyl-iso-propyl-acetic and probably ethyl-octaethenyl-iso-propyl-acetic acid.

Communications from the Chemical Laboratory at Greifswald.—These consist of a memoir on an azo-sulpho-benzolic acid, by Dr. Mahrenholtz and Dr. Gilbert, a paper on azo-oxysulpho-benzolic acid by Dr. C. Brunnmann; reseaches by W. Balentine on the diazo-compound of hydrazo-sulpho-benzolic acid; and a memoir on dibrom- and tetrabrom hydrazo-sulpho-benzolic acid.

Communication from the Laboratory of the University of Halle.—These communications include a paper by Max Barth, on the combination of alumina with carbonic acid and ammonia, and a notice on diethylidenlactamidic acid, by W. Heintz. Herr Barth considers that the existence of an aluminium carbonate is not yet demonstrated.

Journal für Praktische Chemie.
Nos. 7 and 8, 1880.

The Behaviour of Sugars with Alkaline Solutions of Copper and Mercury (Conclusion).—Dr. Soxhlet.—If the reductive power of a sugar with Fehling's solution is smaller than that of grape sugar this applies also to Knapp's and Sachsse's solutions. The contrary holds good with inverted sugar and levulose. The proportion found for one of the three solutions does not apply to the others. Milk sugar, however, shows an equally diminished reductive power with the solutions of Fehling and of Sachsse. The two mercurial methods have no advantage over Fehling's method as regards accuracy, certainty, and convenience. The author gives the preference to Fehling's process, since it admits of the use of larger quantities of sugar, and since the point when the reduction is completed is most distinctly marked. The mercury methods are, however, of use when it is required to ascertain the identity of a sugar, or to determine two sugars occurring together.

Nitro-ortho- and Nitro-para-azo-phenetols.—Dr. Hans Andreæ.—During the nitration of ortho-azo-phenetol there are formed two isomeric dinitro-azo-phenetols, whilst from parazo-phenetol there may be obtained two isomeric trinitro-azoxy-phenetols and a dinitro-phenetol. The nitro groups introduced into ortho-azo-phenetol effect the conversion of the azo into the hydrazo compound, but by reason of their negative character they prevent the conversion into the isomeric diphenyl base.

On Ethylated Ortho amido-phenetols and Ortho-amido-phenols.—Dr. Förster.—This paper does not admit of useful abstraction.

Chloro-sulphonic Ether.—P. Clæsson.—A reply to the strictures of Dr. Behrend (vol. xx., p. 382).

Antiseptic Action of Salicylic Acid.—A. Schultz.—The author gives tables showing the what kinds of substances and in what proportion are able to combine with salicylic acid.

Correspondenz-Blatt des Vereines Analytischer Chemiker.
No. 8, April 15, 1880.

Apparatus for Testing Petroleum.—Prof. C. Engler.—This memoir cannot be usefully abstracted without the accompanying illustrations.

Universal Spectroscope for Chemical and Physical Laboratories.—C. H. Wolff.—Also an illustrated paper.

Examination of Soil for Coal-gas Products.—E. Königs.—An examination of earth which had become saturated with coal-gas. The author worked up samples of soil into a paste acidulated with sulphuric acid and passed a current of steam into the mixture. The gases and vapours given off were collected in glass receivers. The bulk of the product consisted of naphthalin. Carbolic acid was not obtained in sensible quantity.

Die Chemische Industrie.
No. 5, May, 1880.

Technical Analysis and Valuation of Mond's Sulphur Lyes.—Dr. K. Jurisch.—The three following tests are recommended:—(1.) Take 3·2 c.c. of the sulphur lye, add a solution of sodium acetate, and then an excess of solution of zinc sulphate; dilute to 200 c.c., filter off 100 c.c., add a little starch mucilage, and titrate with a decinormal solution of iodine, and multiply the number of c.c. of the iodine solution required by 2. (2.) Take 3·2 c.c. of the same sulphur lye, add starch mucilage, and titrate with decinormal solution of iodine. (3.) Decolourise the liquid obtained in the last test by adding a drop of a solution of sodium dithionite; add some tincture of litmus and titrate with decinormal caustic potassa. In order to find the precipitable sulphur multiply the c.c. of the iodine solution of the first test by 5. If this product is greater than the number of c.c. of the iodine solution of the second test the lye is over-blown, *i.e.*, oxidised too much. If this product is smaller than the number of the c.c. of the second test the lye is under-blown, *i.e.*, not oxidised enough. Subtract the smaller number from the larger and divide the difference in the former case by 40, and in the latter case by 20. The quotient thus obtained is subtracted from the total quantity of sulphur present.

No. 6, June, 1880.

Testing Weldon Mud.—Dr. Jurisch.—The author gives an account of a method which has been in use since 1878 at the works of James Muspratt and Sons, at Widnes.

Determination of the Proportion of Anhydride in Fuming Sulphuric Acid.—Clemens Winckler.—This memoir will be inserted at length.

Verhandlungen des Vereins zur Beforderung des Gewerbfleisses. Nos. 4 and 5, April and May, 1880.

These issues contain no chemical matter.

No. 6, June, 1880.

Machines for the Separation of Magnetic and Non-magnetic Ores.—Dr. Siemens.

Apparatus for Measuring the Rapidity of a Gaseous Current—Dr. O. Braun.—These two papers cannot be usefully abstracted without the accompanying woodcuts.

Weighting Textile Fabrics.—Dr. Grothe.—The author gives an account of the sizing of cotton tissues as at present carried on in England. Dr. Franke pointed out that this custom is by no means peculiar to England, and remarked that silks are weighted in a far larger proportion than cottons—sometimes up to 400 per cent.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
No. 3, 1880.

Methylated Dioxethylen-amines.—H. F. Morley.—An account of the preparation and properties of monomethyl-dioxethylen-amine and the corresponding di compound.

Oxidation of Substituted Phenols.—G. Magatti.—The author has obtained tetra-brom-diphenol, and on oxidising it with a small quantity of nitric acid after solution in glacial acetic acid, he produces a crystalline substance, $C_{12}H_4Br_4O_2$, which is dark red-brown by transmitted, but steel-blue by reflected light, and which is tetra-brom-diphenol-quinon, analogous to cedriret. Corresponding chlorine compounds have also been examined.

Certain Derivatives of Para-brom-aniline.—M. Dennstedt.—The author has prepared and examined brom-phenyl-urethan, brom-phenyl-cyanate, brom-phenyl-methyl-urethan, brom-phenyl-dicyanate, and dibrom-phenyl-biuret. From the bromo-phenylated oil of mustard he has obtained mono-brom-phenyl-sulphurea, phenyl-brom-phenyl-sulphurea, brom-phenyl-urethan-hemi-sulphide, sulpho-brom-phenyl-urethan, iso-cyan-mono-brom-phenyl-chloride, ethenyl-dibrom-phenyl-diamine, formo-brom-anilide, thio-formo-brom-anilide, brom-phenyl-glycocoll, and its brom-anilide (dibrom-phenyl-oxethylen-urea and brom-phenyl-glycocoll-ethyl ether.

Crystalline Form of Ortho-thio-formic Benzyl-ether.—M. Dennstedt.—This substance crystallises in the rhombic system. The measurements of the angles are given.

Question of the Origin of Hypoxanthine from Albuminoid Bodies.—E. Drechsel.—A critique on the theory of Salomon, Krause, and Chittenden, that the xanthine compounds do not exist pre-formed in albuminoid bodies.

Vesbium and Norwegium.—C. Rammelsberg.—Already inserted.

NOTES AND QUERIES.

Vanadium Ink.—Your correspondent (J. C.) can buy vanadium ink from Mr. George Dutton, Chemist, 21, Bennett Street, Newton Heath, Manchester.—J. Smith.

TO CORRESPONDENTS.

A. L. Burrell.—We know of no process which will give you phosphorus absolutely and chemically pure, and we do not think any manufacturer would guarantee the absolute chemical purity of anything they sold.

THE LONDON HOSPITAL and MEDICAL COLLEGE, MILE END, E.—The SESSION 1880-81 will commence on FRIDAY, OCTOBER 1st, 1880. Four entrance Scholarships, value £60, £40, £30, and £20, will be offered for competition at the end of September to new Students. Entries on or before September 20. Fees for Lectures and Hospital Practice, 90 guineas in one payment, or 100 guineas in three instalments. All resident and other hospital appointments are free. The resident appointments consist of Five House Physiciancies, Four House Surgeoncies, and One Accoucheurship; Two Dressers and Two Maternity Pupils also reside in the Hospital. Special entries may be made for Medical and Surgical Practice. The London Hospital is now in direct communication by rail and tram with all parts of the Metropolis.
MUNRO SCOTT, Warden.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

SPECIALITIES.

MANGANESE—Finest Crystallised, Lump, Ground, and Granulated of every quality, and PREPARED for *Chlorine, Glass, Steel, Ferro-Manganese, Pottery, Battery,* and EVERY PURPOSE.

BAUXITE—(Hydrate of Alumina) Of high percentage of Alumina and almost free from Iron. The CHEAPEST, BEST, and MOST PROFITABLE article from which to produce ALUM, ALUM CAKE, and SULPHATE OF ALUMINA, &c. [BRAND, "IRISH HILL BAUXITE."]

FLUOR-SPAR—Of the Very Finest Quality for Acid, Soda, Glass Flux, and all purposes.

BARYTES—(Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

CRYOLITE—Magnesite, Felspar, Arsenic, Phosphates, French Chalk, Strontia, Wolfram, Chromie, Terra Alba, Rotten Stone, China Clay, Umbers' Ochres, Antimony, Calamine, Emery Stone' all Oxides, and all

FULLER'S EARTH—Of superior quality, and entirely free from grit. [BRAND, "EMERALD."]

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,

MINE PROPRIETOR,

Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.

OFFICES—26 CHAPEL STREET, LIVERPOOL.

BISULPHIDE OF CARBON

PROTOSULPHATE

RED OXIDE

OXYCHLORIDE

Sulphocyanide,

And every other Mercurial Preparation.

BISULPHITE OF LIME, TETRACHLORIDE OF CARBON.

Oxysulphuret of Antimony, Glacial Acetic Acid,

LIQUOR AMMONIÆ,
SULPHIDE OF IRON,
PURE ACIDS,
CHLORIDE OF SULPHUR,
ACETONE,
CHLOROFORM,
ALDEHYDE,
CHLORATE BARYTA,
ARSENIC ACIDS,
FRUIT ESSENCES FOR CONFECTIONERY & LIQUEURS,
PERCHLORIDE OF IRON,
SULPHITE AND HYPOSULPHITE OF SODA,
PHOSPHATES OF SODA AND AMMONIA,
ETHERS,
BROMIDES,
IODIDES,
SCALE AND GRANULAR PREPARATIONS,
SULPHIDE OF SODIUM.

ALSO,

Pure Photographic Chemicals of every kind.

MANUFACTURED BY

WILLIAM BAILEY & SON,

HORSELEY FIELDS CHEMICAL WORKS,
WOLVERHAMPTON.

SOUTH LONDON SCHOOL OF PHARMACY.

Special advantages are offered to Private Students during the Vacation in every branch of Practical Chemistry, as applied to Manufactures, Agricultural and Commercial Products, Water, Gas, Food, &c.

For terms, personal or by letter, W. BAXTER, Secretary, Central Public Laboratory, Kennington Cross, S.E.

TO BE LET OR SOLD, on moderate terms, the whole or any portion of a Works situate near Wolverhampton, in a good state of repair, and having an area of about an acre. There is a branch from a main line of railway running into every part of the Works, and an extensive frontage to a Canal Wharf. The use of neighbouring boilers and engines may be had if required. Adjoins Oil of Vitriol and Manure Works, and unused Phosphorus and Copper Extracting (wet process) Works.—Address, Messrs. Slater and Marshall, Solicitors, Darlaston, near Wednesbury, Staffordshire.

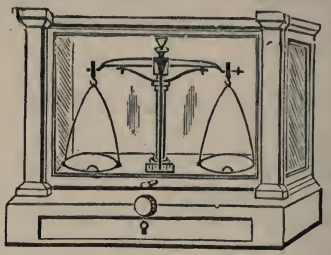
BECKER & SONS,

MANUFACTURERS OF

CHEMICAL AND GOLD ASSAY BALANCES AND OTHER

SCALES AND WEIGHTS.

ROTTERDAM.



NEW YORK.

BECKER'S STUDENT'S BALANCE, in polished mahogany glass case, sliding front, counterpoised, to carry 30 grammes in each pan and turn to ½ milligramme, nickel plated pans £2 10
Ditto, ditto, in mahogany glass case, polished black.. .. .. £2 13

Sole Agents for England, Ireland, and Wales:—

TOWNSON & MERCER.

Becker's Complete Lists forwarded by post on receipt of 1*d.* stamp or free on application.

CHEMICAL & PHYSICAL APPARATUS,

BOTTLES, PURE CHEMICALS,

REAGENTS, STANDARD SOLUTIONS,

And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

MOTTERSHEAD & CO.,

7, Exchange Street and 10, Half Moon Street,

MANCHESTER.

BISULPHIDE OF CARBON,

CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,

161, 162, 163, PALMERSTON BUILDINGS, LONDON, E.C.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

WILLIAM AND WILLIAM T. FIELD

MANUFACTURERS of the Celebrated STAFFORDSHIRE BLUE BRICKS, specially adapted for Chemical Plant, *i.e.*, Acid Towers, &c. Also all other kinds of Best Staffordshire Blue Bricks, Pavings, Plynths, Splays, Copings, &c. &c. Prices and samples on Application.

TESTIMONIAL.

"We have used the Blue Staffordshire Brick or Sulphuric Acid Towers, &c., manufactured by Messrs. Field, for the last fifteen years during which time they have given great satisfaction. We recommend them to the Chemical Trade, believing there is nothing better in the market."—(Signed) WILLIAM HUNT and SONS, Lea Brook Alkali Works, near Wednesbury, Staffordshire, February, 1878.

TOLL END BRICK-WORKS,
TIPTON, STAFFORDSHIRE.

THE CHEMICAL NEWS.

Vol. XLII. No. 1083.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Swansea Meeting, August 25, 1879.

INAUGURAL ADDRESS OF THE PRESIDENT,

Andrew Crombie Ramsay, LL.D., F.R.S., V.P.G.S.,
Director-General of the Geological Survey of the United Kingdom and of the Museum of Practical Geology.

On the Recurrence of Certain Phenomena in Geological Time.

In this address I propose to consider the recurrence of the same kind of incidents throughout all geological time, as exhibited in the various formations and groups of formations that now form the known parts of the external crust of the earth. This kind of investigation has for many years forced itself on my attention, and the method I adopt has not heretofore been attempted in all its branches. In older times, Hutton and Playfair, in a broad and general manner, clearly pointed the way to the doctrine of uniformity of action and results, throughout all known geological epochs down to the present day; but after a time, like the prophets of old, they obtained but slight attention, and were almost forgotten, and the wilder cosmical theories of Werner more generally ruled the opinions of the geologists of the time. Later still, Lyell followed in the steps of Playfair, with all the advantages that the discoveries of William Smith afforded, and aided by the labours of that band of distinguished geologists, Sedgwick, Buckland, Mantell, De la Beche, Murchison, and others, all of whom some of us knew. Notwithstanding this new light, even now there still lingers the relics of the belief (which some of these geologists also maintained), that the physical phenomena which produced the older strata were not only different in kind, but also in degree from those which now rule the external world. Oceans, the waters of which attained a high temperature, attended the formation of the *primitive* crystalline rocks. Volcanic eruptions, with which those of modern times are comparatively insignificant, the sudden upheaval of great mountain-chains, the far more rapid decomposition and degradation of rocks, and, as a consequence, the more rapid deposition of strata formed from their waste—all these were assumed as certainties, and still linger in some parts of the world among living geologists of deservedly high reputation. The chief object of this address is, therefore, to attempt to show, that whatever may have been the state of the world long before geological history began, as now written in the rocks, all known formations are comparatively so recent in geological time, that there is no reason to believe that they were produced under physical circumstances differing either in kind or degree from those with which we are now more or less familiar.

It is unnecessary for my present purpose to enter into details connected with the recurrence of marine formations, since all geologists know that the greater part of the stratified rocks were deposited in the sea, as proved by the molluscs and other fossils which they contain, and the order of their deposition and the occasional stratigraphical breaks in succession are also familiar subjects. What I have partly to deal with now, are exceptions to true marine stratified formations, and after some other important questions have been considered, I shall proceed to discuss the origin of various non-marine deposits from nearly the earliest known time down to what by comparison may almost be termed the present day.

Metamorphism.

All, or nearly all, stratified formations have been in a sense metamorphosed, since, excepting certain limestones, the fact of loose incoherent sediments having been by pressure and other agencies turned into solid rocks constitutes a kind of metamorphism. This, however, is only a first step toward the kind of metamorphism, the frequent recurrence of which in geological time I have now to insist upon, and which implies that consolidated strata have undergone subsequent changes of a kind much more remarkable.

Common stratified rocks chiefly consist of marls, shales, slates, sandstones, conglomerates, and limestones, generally distinct and definite; but not infrequently a stratum, or strata, may partake of the characters in varied proportions of two or more of the above-named species. It is from such strata that metamorphic rocks have been produced, exclusive of the metamorphism of igneous rocks, on which I will not enter. These may be looked for in every manual of geology, and usually they may be found in them.

As a general rule, metamorphic rocks are apt to be much contorted, not only on a large scale, but also that the individual layers of mica quartz and felspar in gneiss are bent and folded in a great number of minute convolutions, so small that they may be counted by the hundred in a foot or two of rock. Such metamorphic rocks are often associated with masses of granite both in bosses and in interstratified beds or layers, and where the metamorphism becomes extreme it is often impossible to draw a boundary line between the gneiss and the granite; while, on the other hand, it is often impossible to draw any true boundary between gneiss (or other metamorphic rocks) and the ordinary strata that have undergone metamorphism. Under these circumstances it is not surprising that when chemically analysed, there is often little difference in the constituents of the unmetamorphosed and the metamorphosed rock. This is a point of some importance in relation to the origin and non-primitive character of gneiss and other varieties of foliated strata, and also of some quartzites and crystalline limestones.

I am aware that in North America formations consisting of metamorphic rocks have been stated to exist of older date than the Laurentian gneiss, and under any circumstances it is obvious that vast tracts of pre-Laurentian land must have existed in all regions, by the degradation of which, sediments were derived wherewith to provide materials for the deposition of the originally unaltered Laurentian strata. In England, Wales, and Scotland attempts have also been made to prove the presence of more ancient formations, but I do not consider the data provided sufficient to warrant any such conclusion. In the Highlands of Scotland, and in some of the Western Isles, there are gneissic rocks of pre-Cambrian age, which, since they were first described by Sir Roderick Murchison in the North-west Highlands, have been, I think justly considered to belong to the Laurentian series, unconformably underlying Cambrian and Lower Silurian rocks, and as yet there are no sufficient grounds for dissenting from his conclusion that they form the oldest known rocks in the British Islands.

It is unnecessary here to discuss the theory of the causes that produced the metamorphism of stratified rocks, and it may be sufficient to say, that under the influence of deep underground heat, aided by moisture, sandstones have been converted into quartzites, limestones have become crystalline, and in shaly, slaty, and schistose rocks, under like circumstances, there is little or no development of new material, but rather, in the main, a re-arrangement of constituents according to their chemical affinities in rudely crystalline layers, which have very often been more or less developed in pre-existing planes of bedding. The

materials of the whole are approximately the same as those of the unaltered rock, but have been re-arranged in layers, for example, of quartz, felspar, and mica, or of hornblende, &c., while other minerals, such as schorl and garnets, are of not infrequent occurrence.

It has for years been an established fact that nearly the whole of the mountain masses of the Highlands of Scotland (exclusive of the Laurentian, Cambrian, and Old Red Sandstone formations), mostly consist of gneissic rocks of many varieties, and of quartzites and a few bands of crystalline limestone, which, from the north shore to the edge of the Old Red Sandstone, are repeated again and again in stratigraphical convolutions great and small. Many large bosses, veins, and dykes of granite are associated with these rocks, and, as already stated, it sometimes happens that it is hard to draw a geological line between granite and gneiss and *vice versâ*. These rocks, once called Primary or Primitive, were first proved by Sir Roderick Murchison to be of Lower Silurian age, thus revolutionising the geology of nearly one-half of Scotland. To the same age belongs by far the greater part of the broad hilly region of the south of Scotland that lies between St. Abb's Head on the east and the coast of Ayrshire and Wigtonshire on the west. In the south-west part of this district, several great masses of granite rise amid the Lower Silurian rocks, which in their neighbourhood pass into mica-schist and even into fine-grained gneiss.

In Cornwall the occurrence of Silurian rocks is now well known. They are of metamorphic character, and partly associated with granite; and at Start Point, in South Devonshire, the Silurian strata have been metamorphosed into quartzites.

In parts of the Cambrian areas, Silurian rocks in contact with granite have been changed into crystalline hornblendic gneiss, and in Anglesey there are large tracts of presumed Cambrian strata, great part of which have been metamorphosed into chlorite and mica-schist and gneiss, and the same is partly the case with the Lower Silurian rocks of the centre of the island, where it is almost impossible to disentangle them from the associated granite.

In Ireland similar metamorphic rocks are common, and, on the authority of Prof. Hull, who knows them well, the following statements are founded:—"Metamorphism in Ireland has been geographical and not stratigraphical, and seems to have ceased before the Upper Silurian period.

"The epoch of greatest metamorphism appears to have been that which intervened between the close of the Lower Silurian period and the commencement of the Upper Silurian, taking the formations in ascending order.

"It is as yet undecided whether Laurentian rocks occur in Ireland. There are rocks in north-west Mayo very like those in Sutherlandshire, but if they are of Laurentian age they come directly under the metamorphosed Lower Silurian rocks, and it may be very difficult to separate them.

"Cambrian purple and green grits are not metamorphosed in the counties of Wicklow and Dublin, but the same beds at the southern extremity of County Wexford, near Carnsore Point, have been metamorphosed into mica-schist and gneiss.

"In the east of Ireland the Lower Silurian grits and slates have not been metamorphosed, except where in proximity to granite, into which they insensibly pass in the counties of Wicklow, Dublin, Westmeath, Cavan, Longford, and Down; but in the west and north-west of Ireland they have been metamorphosed into several varieties of schists, hornblende-rock, *and gneiss, or foliated granite*."

It would be easy to multiply cases of the metamorphism of Silurian rocks on the continent of Europe, as, for example, in Scandinavia and in the Ural Mountains, where, according to Murchison, "by following its masses upon their strike, we are assured that the same zone which in one tract has a mechanical aspect and is fossiliferous, graduates in another parallel of latitude into a metamorphic crystalline condition, whereby not only the organic remains, but even the original impress of sedimentary origin, are to a great degree obliterated." The same kind of phenomena are common in Canada and the United States; and Medlicott and Blanford, in "The Geology of India," have described the thorough metamorphism of Lower Silurian strata into gneiss and syenitic and hornblende schists.

In Britain, none of the Upper Silurian rocks have undergone any serious change beyond that of ordinary consolidation, but in the Eastern Alps at Gratz, Sir Roderick Murchison has described both Upper Silurian and Devonian strata interstratified with separate courses of metamorphic chloritic schist.

Enough has now been said to prove the frequent occurrence of metamorphic action among Cambrian and Lower and Upper Silurian strata.

If we now turn to the Devonian and Old Red Sandstone strata of England and Scotland, we find that metamorphic action has also been at work, but in a much smaller degree. In Cornwall and Devon, five great bosses of granite stand out amid the stratified Silurian, Devonian, and Carboniferous formations. Adjoining or near these bosses the late Sir Henry De la Beche remarks that "in numerous localities we find the coarser slates converted into rocks resembling mica-slate and gneiss, a fact particularly well exhibited in the neighbourhood of Meavy, on the south-east of Tavistock," and "near Camelford we observed a fine arenaceous and micaceous grauwacke turned into a rock resembling mica-slate near the granite." Other cases are given by the same author, of slaty strata turned into mica-schist and gneiss in rocks now generally considered to be of Devonian age.

The Devonian rocks and Old Red Sandstone are of the same geological age, though they were deposited under different conditions, the first being of marine, and the latter of fresh-water, origin. The Old Red Sandstone of Wales, England, and Scotland has not, as far as I know, suffered any metamorphism, excepting in one case in the north-east of Ayrshire, near the sources of the Avon Water, where a large boss of granite rises through the sandstone, which all round has been rendered crystalline with well-developed crystals of felspar.

On the Continent of Europe, a broad area of Devonian strata lies on both banks of the Rhine and the Moselle. Forty years ago, Sedgwick and Murchison described the crystalline quartzites, chlorite, and micaceous slates of the Hundsruck and the Taunus, and from personal observation I know that the rocks in the country on either side of the Moselle are, in places, of a foliated or semi-foliated metamorphic character. In the Alps also, as already noticed, metamorphic Devonian strata occur interstratified with beds of metamorphic schists, and, Sir Roderick adds, "we have ample data to affirm that large portions of the Eastern Alps . . . are occupied by rocks of true palæozoic age, which in many parts have passed into a crystalline state."

I know of no case in Britain where the Carboniferous strata have been thoroughly metamorphosed, excepting that in South Wales, beds of coal, in the west of Caermarthenshire, and in South Pembrokeshire, gradually pass from so-called bituminous coal into anthracite. The same is the case in the United States, in both instances the Carboniferous strata being exceedingly disturbed and contorted. In the Alps, however, Sir Roderick Murchison seems to have believed that Carboniferous rocks may have been metamorphosed: a circumstance since undoubtedly proved by the occurrence of a coal-measure calamite, well preserved, but otherwise partaking of the thoroughly crystalline character of the gneiss in which it is imbedded and which was shown to me by the late Prof. Gastaldi, at Turin.

I am well acquainted with all the Permian strata of the British Islands and of various parts of continental Europe, and nowhere, that I have seen, have they suffered from metamorphic action, and strata of this age are, I believe, as yet unknown in the Alps. This closes the list of metamorphism of palæozoic strata.

I will not attempt (they are so numerous) to mention all the regions of the world in which Mesozoic or Secondary formations have undergone metamorphic action. In Britain and the non-mountainous parts of France, they are generally quite unaltered, but in the Alps it is different. There, as everyone knows who is familiar with that region, the crystalline rocks in the middle of the chain have the same general strike as the various flanking stratified formations. As expressed by Murchison, "as we follow the chain from N.E. to S.W. we pass from the clearest types of sedimentary rocks, and, at length, in the Savoy Alps, are immersed in the highly altered mountains of Secondary limestone," while "the metamorphism of the rocks is greatest as we approach the centre of the chain," and, indeed, any one familiar with the Alps of Switzerland and Savoy knows that a process of metamorphism has been undergone *by all the Jurassic rocks* (Lias and Oolites) of the great mountain chain. Whether or not any strata of Neocomian and Cretaceous age have been well metamorphosed in this region I am unable to say; but it seems to be certain that the Eocene or Lower Tertiary Alpine formation, known as the Flysch, contains beds of black schists which pass into Lydian stone, and also that in the Grisons it has been converted into gneiss and mica-schist, a fact mentioned by Studer and Murchison. I also have seen in the country north of the Oldenhorn, numinulitic rocks so far foliated that they formed an imperfect gneiss.

In Tierra del Fuego, as described by Darwin, clay slates of early cretaceous date pass into gneiss and mica-slate with garnets, and in Chonos Islands, and all along the great Cordillera of the Andes of Chili, rocks of Cretaceous or Cretaceo-oolitic age have been metamorphosed into foliated mica-slate and gneiss, accompanied by the presence of granite, syenite, and greenstone.

This ends my list, for I have never seen, or heard, of metamorphic rocks of later date than those that belong to the Eocene series. Enough, however, has been said to prove, that from the Laurentian epoch onward, the phenomenon of extreme metamorphism of strata has been of frequent recurrence all through Palæozoic and Mesozoic times, and extends even to a part of the Eocene series equivalent to the soft unaltered strata of the formations of the London and Paris basins, which excepting for their fossil contents, and sometimes highly inclined positions, look as if they had only been recently deposited.

Volcanoes.

The oldest volcanic products of which I have personal knowledge are of Lower Silurian age. These in Wales consist of two distinct series, the oldest of which, chiefly formed of felspathic lavas and volcanic ashes, lie in and near the base of the Llandeilo beds, and the second, after a long interval of repose, were ejected and intermingled with the strata forming the middle part of the Bala beds. The Lower Silurian rocks of Montgomeryshire, Shropshire, Radnorshire, Pembrokeshire, Cumberland, and Westmoreland are to a great extent also the result of volcanic eruptions, and the same kind of volcanic rocks occur in the Lower Silurian strata of Ireland. I know of no true volcanic rocks in the Upper Silurian series.

In the Old Red Sandstone of Scotland lavas and volcanic ashes are of frequent occurrence, interstratified with the ordinary lacustrine sedimentary strata. Volcanic rocks are also intercalated among the Devonian strata of Devonshire. I know of none in America or on the Continent of Europe.

In Scotland volcanic products are common throughout nearly the whole of the Carboniferous sub-formations, and they are found also associated with Permian strata.

I now come to the Mesozoic or Secondary epochs. Of Jurassic age (Lias and Oolites), it is stated by Lyell with some doubt, that true volcanic products occur in the Morea and also in the Apennines, and it seems probable, as stated by Medlicott and Blanford, that the Rajmahal traps may also be of Jurassic age.

In the Cordillera of South America, Darwin has described a great series of volcanic rocks intercalated among the Cretaceo-oolitic strata that forms so much of the chain; and the same author in his "Geological Observations in South America," states that the Cordillera has been, probably with some quiescent periods, a source of volcanic matter from an epoch anterior to our Cretaceo-oolitic formation to the present day. In the Deccan volcanic traps rest on Cretaceous beds, and are overlaid by Nummulitic strata, and according to Medlicott and Blanford, these were poured out in the interval between Middle Cretaceous and Lower Eocene times.

In Europe the only instance I know of a volcano of Eocene age is that of Monte Bolca, near Verona, where the volcanic products are associated with the fissile limestone of that area.

The well-preserved relics of Miocene volcanoes are prevalent over many parts of Europe, such as Auvergne and The Velay, where the volcanic action began in Lower Miocene times, and was continued into the Pliocene epoch. The volcanoes of the Eifel are also of the same general age, together with the ancient Miocene volcanoes of Hungary.

The volcanic rocks of the Azores, Canaries, and Madeira are of Miocene age, while in Tuscany there are extinct volcanoes that began in late Miocene, and lasted into times contemporaneous with the English Coralline Crag. In the north of Spain also, at Olot, in Catalonia, there are perfect craters and cones remaining of volcanoes that began to act in newer Pliocene times and continued in action to a later geological date. To these I must add the great *coulées* of Miocene lava, so well known in the Inner Hebrides, on the mainland, near Oban, &c., in Antrim in the north of Ireland, in the Faroe Islands, Greenland, and Franz-Joseph Land. It is needless, and would be tiresome, further to multiply instances, for enough has been said to show that in nearly all geological ages volcanoes have played an important part, now in one region, now in another, from very early Palæozoic times down to the present day; and, as far as my knowledge extends, at no period of geological history is there any sign of their having played a more important part than they do in the epoch in which we live.

Mountain-Chains.

The mountain-chains of the world are of different geological ages, some of them of great antiquity, and some of them comparatively modern.

It is well known that in North America the Lower Silurian rocks lie uncomformably on the Laurentian strata, and also that the latter had undergone a thorough metamorphism and been thrown into great anticlinal and synclinal folds, accompanied by intense minor convolutions, before the deposition of the oldest Silurian formation, that of the Potsdam Sandstone. Disturbances of the nature alluded to imply beyond a doubt that the Laurentian rocks formed a high mountain-chain of pre-Silurian date, which has since constantly been worn away and degraded by sub-aërial denudation.

In Shropshire, and in parts of North Wales, and in Cumberland and Westmoreland, the Lower Silurian rocks by upheaval formed hilly land before the beginning of the Upper Silurian epoch; and it is probable that the Lower Silurian gneiss of Scotland formed mountains at the same time, probably very much higher than now. However that may be, it is certain that these mountains formed high land before and during the deposition of the old Red Sandstone, and the upheaval of the great Scandinavian chain (of which the Highlands may be said to form an outlying portion) also preceded the deposition of the Old Red Strata. In both of these mountain regions the rocks have since undergone considerable movements, which in the main seem to have been movements of elevation, accompanied undoubtedly by that constant atmospheric degradation to which all high land is especially subject.

The next great European chain in point of age is that of the Ural, which according to Murchison is of pre-

Permian age, a fact proved by the Permian conglomerates which were formed from the waste of the older strata. On these they lie quite unconformably and nearly undisturbed on the western flank of the mountains.

In North America the great chain of the Alleghany Mountains underwent several disturbances, the last (a great one) having taken place after the deposition of the Carboniferous rocks, and before that of the New Red Sandstone. The vast mountainous region included under the name of the Rocky Mountains, after several successive disturbances of upheaval, did not attain its present development till after the Miocene or Middle Tertiary epoch.

In South America, notwithstanding many oscillations of level recorded by Darwin, the main great disturbance of the strata that form the chain of the Andes took place apparently *in post-cretaceous times.*

The Alps, the rudiments of which began in more ancient times, received their greatest disturbance and upheaval in post-Eocene days, and were again raised at least 5000 feet (I believe much more) at the close of the Miocene epoch. The Apennines, the Pyrenees, the Carpathians, and the great mountain region on the east of the Adriatic and southward into Greece, are of the same general age, and this is also the case in regard to the Atlas in North Africa and the Caucasus on the borders of Europe and Asia. In the north of India the history of the Great Himalayan range closely coincides with that of the Alps, for while the most powerful known disturbance and elevation of the range took place after the close of the Eocene epoch, a subsequent elevation occurred in post-Miocene times closely resembling and at least equal to that sustained by the Alps at the same period.

It would probably not be difficult by help of extra research to add other cases to this notice of recurrences of the upheaval and origin of special mountain chains, some of which I have spoken of from personal knowledge; but enough has been given to show the bearing of this question on the argument I have in view, namely, that of epetition of the same kind of events throughout all known geological time.

Salt and Salt Lakes.

I now come to the discussion of the circumstances that produced numerous recurrences of the development of beds of various salts (chiefly common rock-salt) in many formations, which it will be seen are to a great extent connected with continental or inland conditions. In comparatively rainless countries salts are often deposited on the surface of the ground by the effect of solar evaporation of moisture from the soil. Water dissolves certain salts in combination with the ingredients of the underlying rocks and soils, and brings it to the surface, and when solar evaporation ensues the salt or salts are deposited on the ground. This is well known to be the case in and near the region of the Great Salt Lake in North America, and in South America in some of the nearly rainless districts of the Cordillera, extensive surface-deposits of salts of various kinds are common. The surface of the ground around the Dead Sea is also in extra dry seasons covered with salt, the result of evaporation, and in the upper provinces of India (mentioned by Medlicott and Blanford) "many tracts of land in the Indo-Gangetic alluvial plain are rendered worthless for cultivation by an efflorescence of salt known in the North-West Provinces as *Reh*," while every geographer knows that in Central Asia, from the western shore of the Caspian Sea to the Kinshan Mountains of Mongolia, with rare exceptions nearly every lake is salt in an area at least 3500 miles in length. This circumstance is due to the fact that all so-called fresh-water springs, and therefore all rivers, contain small quantities of salt in solution only appreciable to the chemist, and by the constant evaporation of pure water from the lakes, in the course of time it necessarily happens that these salts get concentrated in the water by the effect of solar heat, and, if not already begun, precipitation of solid salts must ensue.

The earliest deposits of rock-salt that I know about have been described by Mr. A. B. Wynne, of the Geological Survey of India, in his memoir "On the Geology of the Salt Range in the Punjab."* The beds of salt are of great thickness, and along with gypsum and dolomitic layers occur in marl of a *red colour* like our Keuper Marl. This colour I have for many years considered to be, in certain cases, apt to indicate deposition of sediments in inland lakes, salt or fresh, as the case may be; and with respect to these strata in the Punjab Salt Range, authors seem to be in doubt whether they were formed in inland lakes or in lagoons near the seaboard, which at intervals were liable to be flooded by the sea, and in which in the hot seasons salts were deposited by evaporation caused by solar heat. For my argument it matters but little which of these was the true physical condition of the land at the time, though I incline to think the inland lake theory most probable. The age of the strata associated with this salt is not yet certainly ascertained. In "The Geology of India" Medlicott and Blanford incline to consider them of Lower Silurian age, and Mr. Wynne, in his "Geology of the Salt Range," places the salt and gypsum beds doubtfully on the same geological horizon.

The next salt-bearing formation that I shall notice is the Salina or Onondaga Salt Group of North America, which forms part of the Upper Silurian rocks, and lies immediately above the Niagara Limestone. It is rich in gypsum and in salt-brine, often of a very concentrated character, "which can only be derived from original depositions of salt," and it is also supposed by Dr. T. Sterry Hunt to contain solid rock-salt 115 feet in thickness at the depth of 2085 feet, near Saginaw Bay, in Michigan.

In the Lower Devonian strata of Russia, near Lake Ilmen, Sir R. Murchison describes salt springs at Starai Russa. Sinkings "made in the hope of penetrating to the source of these salt springs" reached a depth of 600 feet without the discovery of rock-salt, "and we are left in doubt whether the real source of the salt is in the lowest beds of the Devonian rocks or even in the Silurian system."

In the United States brine springs also occur in Ohio, Pennsylvania, and Virginia, in Devonian rocks.

In Michigan, salts are found from the Carboniferous down to the Devonian series; and in other parts of the United States, Western Pennsylvania, Virginia, Ohio, Illinois, and Kentucky, from the lower Coal-measures salts are derived which must have been deposited in inland areas, since even in the depths of inland seas that communicate with the great ocean, such as the Mediterranean and the Red Sea, no great beds of salt can be deposited. Before such strata of salt can be formed supersaturation must have taken place.

In the North of England, at and near Middlesborough, two deep bore-holes were made some years ago in the hope of reaching the Coal-measures of the Durham coalfield. One of them at Salthome was sunk to a depth of 1355 feet. First they passed through 74 feet of superficial clay and gravel, next through about 1175 feet of red sandstones and marls, with beds of rock-salt and gypsum. The whole of these strata (excepting the clay and gravel) evidently belong to the Keuper marls and sandstones of the upper part of our New Red series. Beneath these they passed through 67 feet of dolomitic limestone, which in this neighbourhood forms the upper part of the Permian series, and beneath the limestone the strata consist of 27 feet of gypsum and rock-salt and marls, one of the beds of rock-salt having a thickness of 14 feet. This bed of Permian salt is of some importance, since I have been convinced for long that the British Permian strata were deposited, not in the sea, but in salt lakes comparable in some respects to the great salt lake of Utah, and in its restricted fauna to the far greater salt-lake of the Caspian Sea. The gypsum, the dolomite or magnesian limestone, the red marls covered with rain-pittings, the sun-cracks, and the impressions of footprints of reptiles made in the

* Many earlier notices and descriptions of the Salt Range might be quoted, but Mr. Wynne's is enough for my purpose.

soft sandy marls when the water was temporarily lowered by the solar evaporation of successive summers, all point to the fact that our Permian strata were not deposited in the sea, but in a salt lake or lakes once for a time connected with the sea. The same may be said of other Permian ares in the central parts of the Continent of Europe, such as Stassfurt and Anhalt, Halle and Altern, in Thuringia, and Sperenberg, near Berlin, and also in India.*

Neither do I think that the Permian strata of Russia, as described by Sir Roderick Murchison, were necessarily, as he implies, deposited in a wide ocean. According to his view all marine life universally declined to a minimum after the close of the Carboniferous period, that decline beginning with the Permian and ending with the Triassic epoch. Those who believe in the doctrine of evolution will find it hard to accept the idea which this implies, namely, that all the prolific forms of the Jurassic series sprang from the scanty faunas of the Permian and Triassic epochs. On the contrary, it seems to me more rational to attribute the poverty of the faunas of these epochs to accidental abnormal conditions in certain areas, that for a time partially disappeared during the deposition of the continental Muschelkalk which is absent in the British Triassic series.

In the whole of the Russian Permian strata only fifty-three species were known at the time of the publication of "Russia and the Ural Mountains," and I have not heard that this scanty list has been subsequenly increased. I am therefore inclined to believe that the red marls, grits, sandstones, conglomerates, and great masses of gypsum and rock-salt were all formed in a flat inland area which was occasionally liable to be invaded by the sea during intermittent intervals of minor depression, sometimes in one area, sometimes in another, and the fauna small in size and poor in numbers is one of the results, while the deposition of beds of salt and gypsum is another. If so, then in the area now called Russia, in sheets of inland Permian water, deposits were formed strictly analogous to those of Central Europe and of Britain, but on a larger scale.

Other deposits of salt deep beneath overlying younger strata are stated to occur at Bromberg, in Prussia, and many more might be named as lying in the same formation in Northern Germany.

If we now turn to the Triassic series it is known that it consists of only two chief members in Britain, the Bunter Sandstones and the Keuper or New Red Marls, the Muschelkalk of the Continent being absent in our islands. No salt is found in the Bunter sandstones of England, but it occurs in these strata at Schöningen, in Brunswick, and also near Hanover. In the lower part of the Keuper series deposits of rock-salt are common in England and in Ireland. At Almersleben, near Calbe, rock-salt is found in the Muschelkalk, and also at Erfurt and Slottenheim, in Thuringia, and at Wilhelmsglück, in Wurtemberg. In other Triassic areas it is known at Honigsen, in Hanover, in middle Keuper beds. In the red shales at Sperenberg and Lieth on the Lower Elbe, salt was found at the depth of 3000 feet, and at Stassfurth the salt is said to be "several hundred yards thick."

In Central Spain rock-salt is known, and at Tarragona, Taen, and also at Santander, in the north of Spain, all in Triassic strata. Other localities may be named in the Upper Trias, such as the Salzkammergut, Aussee, Hallstatt, Ischl, Hallein in Salzburg, Halle in the Tyrol, and Berchesgaden in Bavaria.

In the Salt Range of mountains in Northern India saliferous strata are referred with some doubt by Medlicott and Blanford to the Triassic strata.

In the Jurassic series (Lias and Oolites) salt and gypsum are not uncommon. One well-known instance occurs at Berg, in the valley of the Rhone, in Switzerland, where salt is derived from the Lias. Salt and gypsum are also found in Jurassic rocks at Burgos, in Spain. At Gap, in France, there is gypsum, and salt is found in the Austrian Alps in Oolitic limestone.

In the Cretaceous rocks salt occurs, according to Lartet, at Jebel Usdom by the Red Sea, and other authorities state that it occurs in the Pyrenees and at Biskra, in Africa, where "mountains of salt" are mentioned as of Cretaceous age. The two last-named localities are possibly uncertain; but whether or not this is the case, it is not the less certain that salt has been deposited in Cretaceous rocks, and, judging by analogy, probably in inland areas of that epoch.

In the Eocene or Older Tertiary formations, rock-salt is found at Cardona, in Spain, and at Kohat, in the Punjab, it occurs at the base of Nummulitic beds. It is also known at Mandi, in India, in strata supposed to be of Nummulitic Eocene age.

The record does not end here, for a zone of rock-salt lies in Sicily at the top of the Salina clays in Lower Miocene beds, and in Miocene strata gypsum is found at several places in Spain, while salt also occurs in beds that are doubtfully of Miocene age (but may be later) at Wielitzka in Poland, Kalusz in Galicia, Bukowina, and also in Transylvania.

In Pliocene or Later Tertiary formation, thick beds of gypsum are known in Zante, and strata of salt occur in Roumania and Galicia, while in Pliocene rocks, according to Dana, or in Post-Tertiary beds, according to others, a thick bed of pure salt was penetrated at a depth of 38 feet at Petit Anse, in Louisiana. This ends my list, though I have no doubt that, by further research, many more localities might be given. Enough, however, has been done to show that rock-salt (and other salts) are of frequent *recurrence* throughout all geological time, and as in my opinion it is impossible that common salt can be deposited in the open ocean, it follows that this and other salts must have been precipitated from solutions, which, by the effect of solar evaporation, became at length supersaturated, like those of the Dead Sea, the great salt lake of Utah, and in other places which it is superfluous to name.

Fresh-water. Lakes and Estuaries.

I now come to the subject of recurrences of fresh-water conditions both in lakes and estuaries. In the introduction to the "Geology of India," by Messrs. Medlicott and Blanford, mention is made of the Blaini and Krol rocks as probably occupying "hollows formed by denudation in the old gneissic rocks," and the inference is drawn that "if this be a correct view, it is probable that the cis-Himalayan palæozoic rocks are in great part of fresh-water origin, and that the present crystalline axis of the Western Himalayas approximately coincides with the shore of the ancient palæozoic continent, of which the Indian peninsula formed a portion." The Krol rocks are classed broadly with "Permian and Carboniferous" deposits, but the Blaini beds are doubtfully considered to belong to Upper Silurian strata. If this point be by-and-bye established, this is the earliest known occurrence of fresh-water strata in any of the more ancient palæozoic formations.

It is a fact worthy of notice that the colour of the strata formed in old lakes (whether fresh or salt) of palæozoic and mesozoic age is apt to be red: a circumstance due to the fact that each little grain of sand or mud is usually coated with a very thin pellicle of peroxide of iron. Whether or not the red and purple Cambrian rocks* may not be *partly* of fresh-water origin, is a question that I think no one but myself has raised.†

There is however, in my opinion, no doubt with regard to the fresh-water origin of the Old Red Sandstone, as distinct from the contemporaneous marine deposits of the

* See "Physical Geology and Geography of Great Britain," fifth edition, where the question is treated in more detail.

* By Cambrian I mean only the *red and purple* rocks of Wales, England, Scotland, and Ireland, older than the Menevian beds, or any later division of the Silurian, strata, that may chance to rest upon them.

† "On the Red Rocks of England of Older Date than the Trias." *Jour. Geol. Soc.*, 1871, vol. xxviii.

Devonian strata. This idea was first started by that distinguished geologist, Doctor Fleming, of Edinburgh, followed by Mr. Godwin-Austen, who, from the absence of marine shells and the nature of the fossil fishes in these strata, inferred that they were deposited, not in the sea, as had always been asserted, but in a great fresh-water lake or in a series of lakes. In this opinion I have for many years agreed, for the nearest analogies of the fish are, according to Huxley, the Polypterus of African rivers, the Ceratodus of Australia, and in less degree the Lepidosteus of North America. The truth of the supposition that the Old Red Sandstone was deposited in fresh water is further borne out by the occurrence of a fresh-water shell, *Anodonta Jukasii*, and of ferns in the Upper Old Red Sandstone in Ireland; and the same shell is found at Dura Den in Scotland, while in Caithness, along with numerous fishes, there occurs the small bivalve crustacean Estheria Murchisoniæ.

I think it more than probable that the red series of rocks that form the Catskill Mountains of North America (and with which I am personally acquainted) were formed in the same manner as the Old Red Sandstones of Britain; for, excepting in one or two minor interstratifications, they contain no relics of marine life, while "the fossil fishes of the Catskill beds, according to Dr. Newberry, appear to represent closely those of the British Old Red Sandstone." (Dana.)

The Devonian rocks of Russia, according to the late Sir Roderick Murchison, consist of two distinct types, viz., Devonian strata identical in general character with those in Devonshire and in various parts of the continent of Europe. These are exclusively of a marine character, while the remainder corresponds to the Old Red Sandstone of Wales, England, and Scotland.

At Tchudora, about 105 miles S.E. of St. Petersburg, the lowest members of the series consist of flag-like compact limestones accumulated in a tranquil sea and containing fucoids and encrinites, together with shells of Devonian age, such as Spirifers, Terebratulæ, Orthis, Leptænas, Avicula, Modiola, Natica, Bellerophon, &c., while the upper division graduates into the Carboniferous series as it often does in Britain, and, like the Old Red Sandstone of Scotland, contains only fish-remains, and in both countries they are of the same species. "Proceeding from the Valdai Hills on the north," the geologist "quits *a Devonian Zone with a true 'Old Red' type* dipping under the Carboniferous rocks of Moscow, and having passed through the latter, he finds himself suddenly in a yellow-coloured region, entirely dissimilar in structure to what he had seen in any of the northern governments, which, of a different type as regards fossils, is the true stratigraphical *equivalent of the Old Red System.*" This seems to me, as regards the Russian strata, to mean, that just as the Devonian strata of Devonshire are the true equivalents of the Old Red Sandstone of Wales and Scotland, they were deposited under very different conditions, the first in the sea and the others in inland fresh-water lakes. At the time Sir Roderick Murchison's work was completed, the almost universal opinion was that the Old Red Sandstone was a marine formation. In the year 1830 the Rev. Dr. Fleming of Edinburgh, read a paper before the Wernerian Society, in which he boldly stated that the "*Old Red Sandstone* is a *fresh-water formation*" of older date than the Carboniferous Limestone. This statement, however, seems to have made no impression on geologists till it was revived by Godwin-Austen in a memoir "On the Extension of the Coal-measures," &c., in the *Journal of the Geological Society*, 1856. Even this made no converts to what was then considered a heretical opinion. I have long held Dr. Fleming's view, and unfortunately published it in the third edition of "The Physical Geology and Geography of Great Britain," without at the time being aware that I had been forestalled by Dr. Fleming and Mr. Godwin-Austen.

To give anything like a detailed account of all the fresh-water formations deposited in estuaries and lakes from the close of the Old Red Sandstone times down to late Tertiary epochs is only fitted for a manual of geology, and would too much expand this Address, and I will therefore give little more than a catalogue of these deposits in ascending order.

In the Coal-measure parts of the Carboniferous series a great proportion of the shales and sandstones are of fresh-water origin. This is proved all over the British Islands by the shells they contain, while here and there marine interstratifications occur, generally of no great thickness. There is no doubt among geologists that these Coal-measure strata were chiefly deposited under estuarine conditions, and sometimes in lagoons or in lakes; while numerous beds of coal formed by the life and death of land plants, each underlaid by the soil on which the plants grew, evince the constant recurrence of terrestrial conditions. The same kind of phenomena are characteristic of the Coal-measures all through North America, and in every country on the continent of Europe, from France and Spain on the west, to Russia in the east, and the same is the case in China and in other areas.

In Scotland, according to Prof. Judd, fresh-water conditions occur more or less all through the Jurassic series, from the Lias to the Upper Oolites. In England, fresh-water strata, with thin beds of coal, are found in the Inferior Oolite of Yorkshire, and in the middle of England and elsewhere in the Great Oolite. The Purbeck and Wealden strata, which, in a sense, fill the interval between the Jurassic and Cretaceous series, are almost entirely formed of fresh-water strata, with occasional thin marine interstratifications. By some the Wealden beds are considered to have been formed in and near the estuary of a great river, while others, with as good a show of reason, believe them to have been deposited in a large lake subject to the occasional influx of the sea.

In the eastern part of South Russia the Lias consists chiefly of fresh-water strata, as stated by Neumayr.

The Godwana rocks of Central India range from Upper Palæozoic times well into the Jurassic strata, and there all these formations are of fresh-water origin. Fresh-water beds with shells are also interstratified with the Deccan traps of Cretaceous and Tertiary (Eocene) age, while 2000 feet of fresh-water sands overlie them.

In South-western Sweden, as stated by Mr. Bauermann, "the three coalfields of Hoganas, Stabbarp, and Rodingé, lie in the uppermost Triassic or Rhætic series." In Africa, the Karoo beds, which it is surmised may be of the age of the New Red Sandstone, contain beds of coal. In North America, certain fresh-water strata, with beds of lignite, apparently belong to the Cretaceous and Eocene epochs, and in the north of Spain and south of France there are fresh-water lacustrine formations in the highest Cretaceous strata.

In England the lower and upper Eocene strata are chiefly of fresh-water origin, and the same is the case in France and other parts of the Continent. Certain fresh-water formations in Central Spain extend from the Eocene to the upper Miocene strata.

There is only one small patch of Miocene beds in England, at Bovey Tracey, near Dartmoor, formed of fresh-water deposits with interstratified beds of lignite or Miocene coal. On the continent of Europe Miocene strata occupy immense independent areas, extending from France and Spain to the Black Sea. In places too numerous to name, they contain beds of "brown coal," as lignite is sometimes called. These coal-beds are often of great thickness and solidity. In one of the pits which I descended near Teplitz, in Bohemia, the coal, which lies in a true basin, is 40 feet thick, and underneath it there is a bed of clay, with rootlets, quite comparable to the underclay which is found beneath almost every bed of coal in the British and other coal-fields of the Carboniferous epoch. The Miocene rocks of Switzerland are familiar to all geologists who have traversed the country between the Jura and the Alps. Sometimes they are soft and incoherent, sometimes formed of sandstones, and sometimes of con-

glomerates, as on the Righi. They chiefly consist of fresh-water lacustrine strata, with some minor marine inter-stratifications which mark the influx of the sea during occasional partial submergences of portions of the area. These fresh-water strata, of great extent and thickness, contain beds of lignite, and are remarkable for the relics of numerous trees and other plants, which have been described by Prof. Heer, of Zurich, with his accustomed skill. The Miocene fresh-water strata, of the Sewalik Hills in India, are well known to most students of geology, and I have already stated that they bear the same relation to the more ancient Himalayan Mountains that the Miocene strata of Switzerland and the north of Italy do to the pre-existing range of the Alps. In fact, it may be safely inferred that something far more than the rudiments of our present continents existed long before Miocene times, and this accounts for the large areas on those continents which are frequently occupied by Miocene fresh-water strata. With the marine formations of Miocene age this address is in no way concerned, nor is it essential to my argument to deal with those later tertiary phenomena, which in their upper stages so easily merge into the existing state of the world.

Glacial Phenomena.

I now come to the last special subject for discussion in this address, viz., the Recurrence of Glacial Epochs, a subject still considered by many to be heretical, and which was generally looked upon as an absurd crotchet when, in 1855, I first described to the Geological Society, boulder-beds, containing ice-scratched stones, and erratic blocks in the Permian strata of England. The same idea I afterwards applied to some of the Old Red Sandstone conglomerates, and of late years it has become so familiar, that the effects of glaciers have at length been noted by geologists from older Palæozoic epochs down to the present day.

In the middle of last July I received a letter from Prof. Geikie, in which he informed me that he had discovered mammillated *moutonnée* surfaces of Laurentian rocks, passing underneath the Cambrian sandstones of the north-west of Scotland at intervals, all the way from Cape Wrath to Loch Torridon, for a distance of about 90 miles. The mammillated rocks are, says Prof. Geikie, "*as well rounded off as any recent roche moutonnée*," and, "in one place these bosses are covered by a huge angular breccia of this old gneiss (Laurentian) with blocks sometimes five or six feet long." This breccia, where it occurs, forms the base of the Cambrian strata of Sutherland, Ross, and Cromarty, and while the higher strata are always well stratified, where they approach the underlying Laurentian gneiss, "they become pebbly, passing into coarse unstratified agglomerates or boulder-beds." In the Gairloch district, "it is utterly unstratified, the angular fragments standing on end and at all angles," just as they do in many modern moraine mounds wherever large glaciers are found. The general subject of Palæozoic glaciers has long been familiar to me, and this account of more ancient glaciers of Cambrian age is peculiarly acceptable.

The next sign of ice in Britain is found in the Lower Silurian rocks of Wigtonshire and Ayrshire. In the year 1865 Mr. John Carrick Moore took me to see the Lower Silurian graptolitic rocks at Corswall Point in Wigtonshire, in which great blocks of gneiss, granite, &c., are imbedded, and in the same year many similar erratic blocks were pointed out to me by Mr. James Geikie in the Silurian strata of Carrick in Ayrshire. One of the blocks at Corswall, as measured by myself, is nine feet in length, and the rest are of all sizes, from an inch or two up to several feet in diameter. There is no gneiss or granite in this region nearer than those of Kirkcudbrightshire and Arran, *and these are of later geological date than the strata amid which the erratic blocks are imbedded.* It is therefore not improbable that they may have been derived from some high land formed of Laurentian rocks of which the outer Hebrides and parts of the mainland of Scotland form surviving portions. If so, then I can conceive of no agent capable of transporting large boulders and dropping them into the Lower Silurian mud of the seas of the time save that of icebergs or other floating ice, and the same view with regard to the neighbouring boulder-beds of Ayrshire is held by Mr. James Geikie. If, however, anyone will point out any other natural cause still in action by which such results are at present brought about, I should be very glad to hear of it.

I must now turn to India for further evidence of the action of palæozoic ice. In the Himalayas of Pangi, S.E. of Kashmir, according to Medlicott and Blanford, "old slates, supposed to be Silurian, contain boulders in great numbers," which they believe to be of glacial origin. Another case is mentioned as occurring in "transition beds of unknown relations," but in another passage they are stated to be "very ancient, but no idea can be formed of their geological position." The *underlying rocks are marked by distinct glacial striations.*

The next case of glacial boulder-beds with which I am acquainted is found in Scotland, and in some places in the north of England, where they contain what seem to be indistinctly ice-scratched stones. I first observed these rocks on the Lammermuir Hills, south of Dunbar, lying unconformably on Lower Silurian strata, and soon inferred them to be of glacial origin, a circumstance that was subsequently confirmed by my colleagues, Prof. and Mr. James Geikie, and is now familiar to other officers of the Geological Survey of Scotland.

I know of no boulder formations in the Carboniferous series, but they are well known as occurring on a large scale in the Permian brecciated conglomerates, where they consist "of pebbles and large blocks of stone, generally angular, imbedded in a marly paste . . . . the fragments have mostly travelled from a distance, apparently from the borders of Wales, and some of them are three feet in diameter." Some of the stones are as well scratched as those found in modern moraines or in the ordinary boulder-clay of what is commonly called the Glacial Epoch. In 1855 the old idea was still not unprevalent that during the Permian Epoch, and for long after, the globe had not yet cooled sufficiently to allow of the climates of the external world being universally affected by the constant radiation of heat from its interior. For a long time, however, this idea has almost entirely vanished, and now, in Britain at all events, it is little if at all attended to, and other glacial episodes in the history of the world have continued to be brought forward and are no longer looked upon as mere ill-judged conjectures.

The same kind of brecciated boulder-beds that are found in our Permian strata occur in the Rotheliegende of Germany, which I have visited in several places, and I believe them to have had a like glacial origin.

Mr. G. W. Stow, of the Orange Free State, has of late years given most elaborate accounts of similar Permian boulder-beds in South Africa. There, great masses of moraine matter not only contain ice-scratched stones, but on the banks of rivers where the Permian rock has been removed by aqueous denudation, the underlying rocks, well rounded and mammillated, *are covered by deeply incised glacier grooves* pointing in a direction which at length leads the observer to the pre-Permian mountains from whence the stones were derived that formed these ancient moraines.*

Messrs. Blanford and Medlicott have also given in "The Geology of India" an account of boulder-beds in what they believe to be Permian strata, and which they compare with those described by me in England many years before. There the Godwana group of the Talchir strata contains numerous boulders, many of them six feet in diameter, and "in one instance *some of the blocks were found to be polished and striated, and the underlying Vindhyan rocks*

* Mr. Stow's last memoir on this subject is still in manuscript. I is so exceedingly long, and the sections that accompany it are of such unusual size, that the Geological Society could not afford their publication. It was thought that the Government of the Orange Free State might undertake this duty, but the late troubles in South Africa have probably hindered this work—it is to be hoped only for a time,

were similarly marked." The authors also correlate these glacial phenomena with those found in similar deposits in South Africa, discovered and described by Mr. Stow.

In the Olive group of the Salt range, described by the same authors, there is a curious resemblance between a certain conglomerate "and that of the Talchir group of the Godwana system." This "Olive conglomerate" belongs to the Cretaceous series, and contains ice-transported erratic bolders derived from unknown rocks, one of which of red granite "is polished and striated on three faces in so characteristic a manner that very little doubt can exist of its having been transported by ice." One block of red granite at the Mayo Salt Mines of Khewra "is 7 feet high and 19 feet in circumference." In the "Transition beds" of the same authors, which are supposed to be of Upper Cretaceous age, there also are boulder beds with erratic blocks of great size.

I know of no evidence of glacial phenomena in Eocene strata excepting the occurrence of huge masses of included gneiss in the strata known as Flysch in Switzerland. On this question, however, Swiss geologists are by no means agreed, and I attach little or no importance to it as affording evidence of glacier ice.

Neither do I know of any Miocene glacier-deposits excepting those in the north of Italy near Turin, described by the late eminent geologist, Gastaldi, and which I saw under his guidance. These contain many large erratic boulders derived from the distant Alps, which, in my opinion, were then at least as lofty or even higher than they are now, especially if we consider the immense amount of denudation which they underwent during Miocene, later Tertiary, and post-tertiary times.

At a still later date there took place in the north of Europe and America what is usually misnamed "*The* Glacial Epoch," when a vast glacial mass covered all Scandinavia, and distributed its boulders across the north of Germany, as far south as the country around Leipzig, when Ireland also was shrouded in glacier ice, and when a great glacier covered the larger part of Britain, and stretched southward, perhaps nearly as far as the Thames on the one side, and certainly covered the whole of Anglesey, and probably the whole, or nearly the whole, of South Wales. This was after the advent of man.

Lastly, there is still a minor Glacial Epoch in progress on the large and almost unknown Antarctic continent, from the high land of which in latitudes which partly lie as far north as 60° and 62°, a vast sheet of glacier-ice of great thickness extends far out to sea and sends fleets of icebergs to the north, there to melt in warmer latitudes. If in accordance with the theory of Mr. Croll, founded on astronomical data, a similar climate were transferred to the northern hemisphere, the whole of Scandinavia and the Baltic would apparently be covered with glacier-ice, and the same would probably be the case with the Faroe Islands and great part of Sibera, while even the mountain tracts of Britain might again maintain their minor systems of glaciers.

Conclusions.

In opening this address, I began with the subject of the oldest metamorphic rocks that I have seen—the Laurentian strata. It is evident to every person who thinks on the subject that their deposition took place *far from the beginning of recognised geological time.* For there must have been older rocks by the degradation of which they were formed. And if, as some American geologists affirm, there are on that continent metamorphic rocks of more ancient dates than the Laurentian strata, there must have been rocks more ancient still to afford materials for the deposition of these pre-Laurentian strata.

Starting with the Laurentian rocks, I have shown that the phenomena of *metamorphism* of strata have been continued from that date all through the later formations, or groups of formations, down to and including part of the Eocene strata in some parts of the world.

In like manner I have shown that ordinary volcanic rocks have been ejected in Silurian, Devonian, Carboniferous, Jurassic, Cretaceo-oolitic, Cretaceous, Eocene, Miocene, and Pliocene times, and from all that I have seen or read of these ancient volcanoes, I have no reason to believe that volcanic forces played a more important part in any period of geological time than they do in this our modern epoch.

So, also, mountain chains existed before the deposition of the Silurian rocks, others of later date before the Old Red Sandstone strata were formed, and the chain of the Ural before the deposition of the Permian beds. The last great upheaval of the Alleghany Mountains took place between the close of the formation of the Carboniferous strata of that region and the deposition of the New Red Sandstone.

According to Darwin, after various oscillations of level, the Cordillera underwent its chief upheaval after the Cretaceous epoch, and all geologists know that the Alps, the Pyrenees, the Carpathians, the Himalayas, and other mountain-chains (which I have named) underwent what seems to have been their chief great upheaval after the deposition of the Eocene strata, while some of them were again lifted up several thousands of feet after the close of the Miocene epoch.

The deposition of salts from aqueous solutions in inland lakes and lagoons appears to have taken place through all time—through Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Eocene, Miocene, and Pliocene epochs—and it is going on now.

In like manner fresh-water and estuarine conditions are found now in one region, now in another, throughout all the formations or groups of formations possibly from Silurian times onward; and glacial phenomena, so far from being confined to what was and is generally still termed *the* Glacial Epoch, are now boldly declared, by independent witnesses of known high reputation, to begin with the Cambrian epoch, and to have occurred somewhere, at intervals, in various formations, from almost the earliest Palæozoic times down to our last post-Pliocene "Glacial Epoch."

If the nebular hypothesis of astronomers be true (and I know of no reason why it should be doubted), the earth was at one time in a purely gaseous state, and afterwards in a fluid condition, attended by intense heat. By-and-bye, consolidation, due to partial cooling, took place on the surface, and as radiation of heat went on, the outer shell thickened. Radiation still going on, the interior fluid matter decreased in bulk, and, by force of gravitation, the outer shell being drawn towards the interior, gave way, and, in parts, got crinkled up, and this, according to cosmogonists, was the origin of the earliest mountain-chains. I make no objection to the hypothesis, which, to say the least, seems to be the best that can be offered and looks highly probable. But, assuming that it is true, these hypothetical events took place so long before authentic geological history began, as written in the rocks, that the earliest of the physical events to which I have drawn your attention in this address was, to all human apprehension of time, so enormously removed from these early assumed cosmical phenomena, *that they appear to me to have been of comparatively quite modern occurrence, and to indicate that from the Laurentian epoch down to the present day, all the physical events in the history of the earth have varied neither in kind nor in intensity from those of which we now have experience.* Perhaps many of our British geologists hold similar opinions, but, if it be so, it may not be altogether useless to have considered the various subjects separately on which I depend to prove the point I had in view.

Action of Phosphorus Perchloride and Oxychloride upon Cinchonine Hydrochlorate.—W. Königs.—These two substances taken singly have little effect upon cinchonine, but if applied jointly a substance is produced which may be regarded as cinchonine where chlorine has taken the place of hydroxyl.—*Berichte der Deutschen.*

THF THALLEIOQUIN TEST.*

By CHARLES FREDERICK ZELLER.

This test, which is one of the most beautiful of the alkaloidal tests, was accidentally discovered by M. J. J. Andre, in 1835. He presented a memoir† to the College of Pharmacy of Paris, "On the Action of Acid on Quinia," in which he endeavours to explain the cause of the fluorescence of quinia solutions, and then the action of chlorine on these solutions. He considered quinia to be a sort of resinate of ammonia, and in attempting to precipitate the resin, which he supposed to have been acted upon by the chlorine, by means of water of ammonia, he obtained a green precipitate, which was immediately re-dissolved by the liquid, and communicated to it a rich emerald colour.

The name was probably derived from the Greek word "Thallos," meaning green, and quinia or chinin, the English and German words indicating the source from which obtained. As this action of chlorine water and ammonia upon quinia had often been spoken of on account of its extreme delicacy, and also of the influence of the presence of hydrochloric acid upon the delicacy of the test, the following experiments were entered into to determine these points. As both quinia and quinidia are similarly acted upon, solutions of both were used.

A. *Solution of Sulphate of Quinia and Fresh Chlorine Water.*

1. Solution of sulphate of quinia (1 in 1000) 100 grs., chlorine water 25 drops=23 grs., liquor ammonia 1 drop =0·8 gr. produced green colour at once.

2. Solution of sulphate of quinia 100 grs., chlorine water 15 drops, dilute ammonia 1 drop, produced first a green colour, then, by carefully shaking up the liquid, there was produced in its stead a beautiful rose colour, which in the course of two hours assumed a brownish colour, which changed in one week to light yellow.

3. Same as No. 2, and after rose colour was produced a second drop of dilute ammonia deepened the colour, third drop changed to dark green, and fourth drop a distinct emeral green.

4. Solution of sulphate of quinia 100 grs., chlorine water 10 drops, dilute ammonia 1 drop; same effect as in No. 2.

5. Solution of sulphate of quinia 100 grs., chlorine water 10 drops, dilute ammonia 1 drop, and then 3 more drops were added, which had the same effect as in No. 3.

6. Solution of sulphate of quinia 100 grs., chlorine water 5 drops, dilute ammonia 1 drop, produced green colour, light at first, but deepens by standing.

7. Solution of sulphate of quinia (1 in 2000) 100 grs., chlorine water 5 drops, diluted ammonia 1 drop, gives green colour well, but does not change to rose colour.

8. Solution of sulphate of quinia (1 in 4000) 100 grs., chlorine water 5 drops, dilute ammonia 1 drop, gives a light green tint, which fades away in about twelve hours.

B. *Solution of Sulphate of Quinidia and Fresh Chlorine Water.*

1. Solution of sulphate of quinidia (1 part in 1000) 100 grs., chlorine water 25 drops=23 grs., liquor ammonia 1 drop=0 8 gr.; same result as A 1.

2 and 3. Solution of sulphate of quinidia, chlorine water and dilute ammonia, same quantities and same results as A 2 and A 3.

4. Solution of sulphate of quinidia 100 grs., chlorine water 10 drops, dilute ammonia 1 drop, gave green colour, did not change to rose.

5. Solution of sulphate of quinidia 100 grs., chlorine water 5 drops, dilute ammonia 1 drop, gave a distinct green colour at once.

6. Solution of sulphate of quinidia (1 in 2000) 100 grs., chlorine water 5 drops, dilute ammonia 1 drop, distinct green, lighter than B 5.

7. Solution of sulphate of quinidia (1 in 4000) 100 grs., chlorine water 5 drops, dilute ammonia 1 drop, gave only a very light greenish yellow tint.

The above experiments were performed in order to obtain the smallest amounts of chlorine water and ammonia which would take part in the reaction; the proportions used by Brande* were: 1 gr. sulphate of quinia in 100 grs. of water, 200 drops of the aqueous solution of chlorine, recently prepared, and 10 or 20 drops of the solution of ammonia. This colour is stated and was proven by experiment to be so intense that it can be diluted with twenty thousand parts of water and it will still retain an appreciable green tint. The proportions recommended in the Pharmacographia are:—Solution of quinia, or one of its salts, 10 volumes, mixed with 1 volume of chlorine water, and then 1 drop of solution of ammonia is added; in solutions containing *less* $\frac{1}{1000}$ of quinia no precipitate is formed. The last-mentioned proportions were tried, but did not produce a perfectly clear liquid. The method of performing the test was as follows: the alkaloidal solution was first poured into the test-tube, the chlorine water then dropped into it, care being taken that none ran along on the side of the test-tube, the drop of ammonia was then dropped into the centre of the liquid; the result was a slight reaction, with the production of white vapours, and a green layer on the top of the liquid, which was then shaken up. The first experiment with both sulphate of quinia and quinidia solutions cause the best and most permanent results, although much smaller amounts of chlorine water and ammonia gave the same results, as may be seen by experiment A 7: the colour is not of the same intensity, becoming lighter as the alkaloidal solution decreases in strength. The liquid as thus obtained is of a beautiful emerald-green colour, has a slight somewhat ammoniacal odour; by standing, an amorphus dark green substance is deposited, which is insoluble in ether, chloroform, and benzine, but soluble in absolute alcohol; when heated it fuses and is decomposed, giving off white vapours having a disagreeable slightly ammoniacal odour. The thalleioquin solution when heated first darkens in colour, and is then decomposed, becoming dark brown.

The experiments which now follow were performed in order to ascertain the effect of hydrochloric acid in chlorine water, tables C and D being given first as representing the most natural way in which acid would be present in chlorine water (by decomposition), the others being given to show the amount of acid which would prevent or modifiy the test. The chlorine water used in tables C and D was over one year old, had been kept in a dark place, in an amber-coloured bottle, tightly corked with a rubber stopper, was nearly colourless, but still had the odour of chlorine; examined by the mercury test before mentioned, it gave an acid reaction with litmus solution.

C. *Solution of Sulphate of Quinia and Old Chlorine Water, Specific Gravity* 1·0012.

1. Solution of sulphate of quinia (1 in 1000) 100 grs., chlorine water 25 drops, solution ammonia 1 drop, gave the emerald-green colour.

2. Solution of sulphate of quinia 100 grs., chlorine water 15 drops, diluted ammonia 1st drop produced a green tint, and in a few seconds the solution was almost colourless and required 3 drops more dilute ammonia to bring back a pale green colour. (No rose colour was produced.)

3. Solution of sulphate of quinia 100 grs., chlorine water 10 drops dilute ammonia 1 drop, gave a very slight yellowish green; 3 drops of dilute ammonia were required to bring out the emerald colour.

4. Solution of sulphate of quinia (1 in 2000) 100 grs., chlorine water 5 drops, dilute ammonia 1st drop a very pale green; 4 drops were required to produce a marked green colour.

* From an Inaugural Essay.
† *Amer. Jour. Pharm.*, 1836, p. 212.

* *Amer. Jour. Pharm.*, 1839, p. 37.

5. Solution of sulphate of quinia (1 in 4000) 100 grs., chlorine water 5 drops, dilute ammonia 1 drop, and then same as C 4, with same result.

D. *Solution of Sulphate of Quinidia and Old Chlorine Water, Specific Gravity* 1·0012.

1. Solution of sulphate of quinidia (1 in 1000) 100 grs., &c.; same as C 1, with same result.

2. Solution of sulphate of quinidia 100 grs., chlorine water 15 drops, dilute ammonia 1 drop, produced first green, then a light rose tint, which deepened on standing.

3. Same as D 2; a second drop of dilute ammonia brought back green colour.

4. Solution of sulphate of quinidia 100 grs., chlorine water 10 drops, dilute ammonia 1 drop, gave green colour.

5. Solution of sulphate of quinidia 100 grs., chlorine water 5 drops, dilute ammonia 1 drop produced a white precipitate.

6. Solution of sulphate of quinidia (1 in 2000) 100 grs., chlorine water 5 drops, dilute ammonia 1 drop; same effect as C 4.

7. Solution of sulphate of quinidia (1 in 4000) in same manner as C 4, with same result, the green which was produced being lighter than by D 6.

It will be seen, by looking over these tables, that as the amount of hydrochloric acid was increased the ammonia was proportionately increased also; for instance, fresh chlorine water without acid required 1 drop solution ammonia to produce the emerald-green colour and this seems to prove that after a certain amount of acid has been neutralised the excess of chlorine bleaches out the colour, forming a yellow solution, which turns to an amber-brown colour if the acid be not present in too large a quantity.

Amount of Solution of Ammonia Required.

Quinia solution—

Old Chlorine Water.	5 p. c. Acid.	10 p. c. Acid.	15 p. c. Acid.	25 p. c. Acid.	50 per cent Acid.
2 drops	2 drops	3 drops	3 drops	5 drops	scarcely shows ppt.

Quinidia—

2 drops	2 drops	3 drops	3 drops	5 drops	scarcely shows ppt

As a matter of interest the bromine water-test was tried, having been recommended as being more delicate than chlorine water. A saturated solution of bromine was made by dissolving 12 drops of bromine in 1 fluid ounce of distilled water. It was found by experiment that 100 grs. of sulphate of quinia or quinidia solution required but 5 drops of bromine water and 1 drop solution ammonia to produce a clear emerald-green colour.

To sum up these experiments it may be stated:—1st. That the chlorine water for performing this test should be freshly prepared is not absolutely necessary, *provided* it is preserved in amber-coloured glass bottles, tightly corked, and kept in a dark place. Chlorine water which had been kept in this manner over a year gave test colour well, as seen in tables C and D. 2nd. That hydrochloric acid, when added to *fresh* chlorine water, in quantities not exceeding 25 per cent, does not prevent its giving the test colour, but will require a proportionately large amount of ammonia to neutralise the acid so added. 3rd. That when hydrochloric acid is present in *old* chlorine water (the result of decomposition) it is due to the loss of chlorine so incurred that the solution loses its value as a test liquid. 4th. It has been shown that bromine water is about four times more delicate than chlorine water, requiring but one-fifth to one-twelfth as much to produce the same results. 5th. On account of the simplicity and ease with which bromine water can be made, it is very much to be preferred as a means of performing the thalleioquin test.—*American Journal of Pharmacy.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin. No. 3, 1880.

Behaviour of Mono-chlor-tetracrylic Acid on Melting.—A. Geuther.—The author remarks that he has been misunderstood by G. W. A. Kahlbaum (*Berichte*, xii., p. 2337).

Dinitro-para-toluidine.—F. Beilstein.—Dinitro-toluidine obtained from para-toluidine may be regarded as proximate meta-dinitro-para-toluidine, whilst that prepared from trinitro-toluol is symmetrical dinitro-toluidine.

Ethylen-iodo-picrate.—L. W. Andrews.—This compound melts at 69·5°, is insoluble in water, sparingly soluble in cold alcohol and in ether, but readily in chloroform. With potassium cyanide it yields a colouring-matter analogous to potassium picro-cyaminate. Ethylen-bromide does not act upon potassium picrate at 130°.

A New Kind of Ammonium Compounds (Memoir 1).—P. Griess.—In this paper the author describes the trimethyl-phenol-ammonium bases, obtained by the action of an excess of methyl-iodide upon the isomeric amido-phenols. He describes ortho-trimethyl-phenol-ammonium, its hydriodate, hemi-hydriodate, hydrochlorate, hydro-nitro-prusside; the platinum double salt and the periodide. Ortho-trimethyl-phenol-ammonium yields on dry distillation ortho-dimethyl-amido-anisol, which greatly resembles dimethyl-aniline, and like it yields peculiar colouring-matters, which the author is examining.

Contribution to the Knowledge of the Protein Bodies.—A. Stutzer.—The copper hydroxide used by Ritthausen for the precipitation of dissolved protein compounds may be advantageously used to separate such bodies from other nitrogenous bodies occurring in vegetable juices. All the protein compounds examined by the author can be resolved into two bodies or two groups by the action of pepsine with hydrochloric acid. On the one hand are formed soluble peptones, acid albuminates, &c., whilst a well-defined portion remains undigested. The latter group contains phosphorus along with nitrogen, and seems to resemble nucleine.

Tropidine.—A. Ladenburg.—Tropidine may also be formed by heating tropine with dilute sulphuric acid.

Hydroscyamine.—A. Ladenburg.—The author regards hydroscyamine as isomeric with atropine. The formula of Höhn and Reichardt is rejected.

Duboisine.—A. Ladenburg.—The object of this paper is a demonstration of the identity of duboisine and hyoscyamine.

The History of Periodic Atomistics.—Lothar Meyer. Noticed elsewhere.

Acetylisation of Certain Carbohydrates on Liebermann's Process.—A. Herzfeld.—Not suitable for abstraction.

Rouge Francaise.—W. v. Miller.—This colour is a mixture of the sodium salts of two tinctorial acids,—a yellow and a red. Both form acicular crystals and yield sparingly soluble barium salts.

Oxyacrylic Acid.—P. Melikoff.—The composition of the potassium salt of this acid is $C_3H_3KO_3+\frac{1}{2}H_2O$.

New Hydrogen Lines and the Dissociation of Calcium.—H. W. Vogel.—Already noticed.

Phenyl-glycolide of Mustard Oil.—C. Liebermann and M. Voeltzkow.—Not suitable for abstraction.

Aromatic Products of the Animal Body.—E. Baumann.—Hydro-para-cumaric acid is readily formed from

tyrosine, which compound may, in the author's opinion, very probably undergo a similar change in the organism. He has succeeded in isolating paroxy-phenyl-acetic acid from human urine.

Preparation of Anthranilic Acid from Ortho-nitro-toluol.—P. Greiff.—Dibrom-nitro-toluol being isomeric with dibrom-anthranilic acid, yielded anthranilic acid on treatment with sodium amalgam.

No. 4, 1880.

Phenyl-lactic Acids.—Emil Erlenmeyer.—The author points out the distinctions between his phenyl-lactic acid and that discovered by Glaser.

Phenyl-brom-lactic Acid.—E. Erlenmeyer.—Not suitable for abstraction.

Ortho-nitro-benzaldehyd and its Behaviour on Treatment with Nascent Hydrogen.—C. Rudolph.—By the action of stannous chloride and hydrochloric acid upon ortho-nitro-benzaldehyd the author has obtained relatively large quantities of a base, C_7H_4ClN, melting at 82° to 84°.

Amides and Anilides of β-Oxybutyric Acid.—L. Balbiano.—The β-amido-butyric amide is a syrupy liquid readily soluble in water and hot alcohol, and very sparingly in ether. The hydro-chlorate of the β-amido-butyric anilide is insoluble in ether, sparingly soluble in boiling water, and melts at 206° to 207°. The free base was not examined.

Disulpho-phenanthrenic Acid and some of its Derivatives.—E. Fischer.—The author forms this acid by gradually adding, with brisk agitation, 1 part of phenanthrene to 4 parts of commercial pyrosulphuric acid, heating finally for quarter to half an hour on the water-bath. The free acid after purification is a brownish yellow syrup, of a very sour and bitter taste, and little disposed to crystallise. Its salts are readily soluble in water and insoluble in alcohol and ether.

A Series of New Colouring-matters.—E. Fischer.—Disulpho-phenanthrenic acid, if heated with phenols, especially resorcin, yields richly coloured condensation-products, closely resembling the phthaleines discovered by Baeyer. If 1 mol. of the acid is heated with 2 mols. resorcin on the water-bath, and the temperature then gradually raised to 195° to 200°, the reaction closely resembles that of phthalic acid and resorcin. The product is a brittle green mass, which, when pulverised, yields a dark brown-red powder, and its solutions are even more fluorescent than the corresponding solutions of fluorescein. The author names this substance phenanthren-sulpheinresorcin. It dissolves with difficulty in water, and the solution dyes silk a yellow. The substance takes up bromine, but its tinctorial power is lost by the action of an excess of this halogen. The rosaniline salts of the sulpheine are remarkably beautiful. If the sulpheine is covered with alcohol and mixed with more than its weight of rosaniline, there is formed a splendid cherry-red solution, which dyes the same shade upon silks. The author proposes the following method for the preparation of disulpho-phenanthrenic acid as commercially available. The phenanthrene is sulphated as above described, poured into water, neutralised with lime, separated by pressure from calcium sulphate, the solution mixed with milk of lime in excess, and the lime precipitated by neutralisation with sulphuric acid. The calcium carbonate thrown down carries with it the impurities.

Iso-phthalo-phenon.—E. Ador.—The author has recognised the symmetric constitution of this body.

Action of Carbonic Oxide upon the Alkali Hydrates at Higher Temperatures.—A. Geuther.—Referring to a paper on the formation of formic acid during the action of carbonic oxide on the hydrates of potassium and sodium at temperatures above 100° (*Berichte*, xiii., p. 23), the author points out that this result was long ago obtained and described by Fröhlich and himself.

Synthesis of Formic Acid.—O. Loew.—As far back as 1864 the author observed that when carbon disulphide and water mixed with iron filings are heated for a length of time to 100° in a closed tube, the final products of the reaction are iron sulphide, ferrous formiate, carbon dioxide, and two bodies consisting of carbon, hydrogen, and sulphur.

Detection and Determination of Chlorine in Presence of Bromine and Iodine.—G. Vortmann.—Inserted at length,

Cinnamic Aldehyd as a Scission-Product in the Pancreatic Digestion of Fibrin.—J. Ossikovsky.—The author detects cinnamic aldehyd among the products by its odour. He considers that this result readily explains the presence of phenyl-propionic and phenyl-acetic acids in the putrefaction of the albuminoid bodies, as discovered by the brothers Salkowski.

Contribution to a Knowledge of the Chemical Constitution of Tyrosine and Skatol.—J. Ossikovsky.—Not adapted for useful abridgment.

Speed of Reactions.—B. Pawlewski.—The author concludes that the speed of reactions as regards hydrochloric and nitric acids of known concentration and pure, recently precipitated barium, strontium, and calcium carbonates, is inversely proportional, not to the molecular weights, but to the atomic weights of the metals of the carbonates.

Occurrence of Vanilline in Certain Raw Beet-root Sugars.—C. Scheibler.—The author has obtained from crude sugars vanilline in quantity sufficient for identification by its odour, its behaviour on sublimation, and its crystalline character.

Certain Dichromates.—K. Preis and B. Rayman.—A description of barium, strontium, and lead dichromates.

Action of Iodine upon Aromatic Compounds with long Lateral Chains.—B. Rayman and K. Preis.—The substances experimented upon are cymol, amyl-benzol, and camphor.

Oxidation of Sulphamin-meta-toluylic Acid.—Ira Remsen.—A controversial paper in reply to a memoir by Jacobsen (*Berichte*, xii., p. 2316).

Splitting up of Inactive Malic Acid.—G. J. W. Bremer.—The author proposes to call the inactive acid, capable of being resolved into two active modications, paramalic acid, and the dextro-rotatory form antimalic acid.

Dinitro-naphthaline.—F. Beilstein and A. Kurbatow.—The authors have submitted the two isomeric dinitro-naphthalines to oxidation in order to throw a light upon their structure.

Dinitro-benzoic Acid.—F. Beilstein and A. Kurbatow.—The authors have obtained dinitro-benzoic acid by the oxidation both of α- and β-dinitro-naphthaline.

Action of Dehydrating Agents upon Acids.—B. Vangel.—The author concludes that the mono-basic acids, under the action of dehydrating agents, yield carbonic acid or carbonic oxide; the bibasic acids evolve both gases in the proportion 1 : 1, and the tribasic the same gases in the proportion 1 : 2.

Condensation of Benzhydrol and Naphthaline.—A. Lehne.—By the condensation of these bodies the author obtained naphthyl-diphenyl-methan. He also describes naphthyl-phenyl-carbinol.

Gluten.—T. Weyl and M. Bischoff.—The author's experiments render it probable that myosine is concerned in the formation of gluten, and that gluten as such does not pre-exist in flour.

Daturine.—E. Schmidt.—The author has not been able to find any distinction, chemical or optical, between daturine and atropine.

Daturine.—A. Ladenburg and G. Meyer.—The authors maintain the identity of daturine, hyoscyamine, and duboisine.

Artificial Formation of Tropic Acid.—A. Ladenburg and L. Rügheimer.—The authors have succeeded in successively bringing hydratropasic acid, atrolactic acid, atropic acid, and tropic acid into genetic connection.

Cubic Alum and the Accommodation of the Chrome Alums.—Alfred Polis.—The author examines the conditions for obtaining cubic alum and its behaviour with other alums as regards overgrowth. The best results were obtained by dissolving 250 grms. alum in 800 c.c. water at 25° to 30°, adding 45 grms. sodium carbonate, and exposing the clear solution to spontaneous evaporation. Ten of the crystals first formed were suspended in the liquid, and after 74 to 92 days they had become pure shining permanent cubes. On suspending such cubic alum in a solution of potash-chrome alum the crystal increased as a cube appearing to be a cubic chrome alum crystal, but displaying small, subordinate octahedral surfaces.

Aromatic Amido-Acids.—F. Tiemann.—The author has prepared and examined phenyl-amido-acetic acid.

Sulphuretted Derivatives of Diphenyl.—S. Gabriel and A. Deutsch.—An account of diphenyl-mono-sulphon-chloride, diphenyl-mono-sulph-hydrate, diphenyl-sulphide, diphenyl-sulphon, diphenyl-disulphide, diphenyl-mono-sulphinic acid, diphenyl-mono-sulphonic-ethyl-ether, diphenyl-sulpho-cyanide, diphenyl-mono-sulphacetic acid, diphenyl-disulphon-chloride, diphenyl-disulphamid, and diphenyl-disulphacetic acid.

Experiments on the Vapour-densities of the Alkaline Metals.—Victor Meyer.—From the author's experiments it appears that the vapour-density of sodium cannot be determined in vessels of glass, porcelain, silver, and platinum. Prof. Meyer intends to procure vessels of graphite.

ROYAL COLLEGE OF SCIENCE FOR IRELAND, STEPHEN'S GREEN, DUBLIN.

SCIENTIFIC AND TECHNICAL EDUCATION.

SESSION 1880-81.

This College supplies a complete Course of Instruction in Science, applicable to the Industrial Arts, especially those which may be classed broadly under the heads of CHEMICAL MANUFACTURES, MINING, and ENGINEERING.

A Diploma of Associate of the College is granted at the end of the Three Years' Course.

There are Four Royal Scholarships of the value of £50 each yearly, with free education, including Laboratory Instruction, tenable for two years. Two become vacant each year. They are given to Students who have been a year in the College.

The Fees are £2 for each Course, or £10 for all the Courses of each year, with the exception of Laboratory Practice.

CHEMISTRY (THEORETICAL AND PRACTICAL) METALLURGY, &c.—Professor HARTLEY, F.C.S.

MATHEMATICS, MECHANICS, AND MECHANISM—Professor HENNESSY, F.R.S.

DESCRIPTIVE GEOMETRY, DRAWING, ENGINEERING, AND SURVEYING—Professor PIGOT, C.E., M.R.I.A.

EXPERIMENTAL PHYSICS (THEORETICAL AND PRACTICAL)—Professor BARRETT, F.R.S.E., F.C.S.

MINING AND MINERALOGY—Professor O'REILLY, C.E., M.R.I.A.

BOTANY—Professor M'NAB, M.D., F.L.S.

ZOOLOGY—Professor BRIDGE, M.A., F.Z.S.

GEOLOGY—Professor HULL, M.A., F.R.S.

PALÆONTOLOGY—Mr. BAILY, F.G.S.

The Chemical and Physical Laboratories and Drawing School are open daily for Practical Instruction.

Fee for Chemical Laboratory, £2 per month, or £12 for Session. Fee for Physical Laboratory, £1 per month, or £6 for Session. Fee for Drawing School, £3 for Session.

The SESSION COMMENCES on MONDAY, OCTOBER 4th.

Programmes may be obtained on application at the College, or by letter or post-card, addressed to the Secretary, Royal College of Science, Stephen's Green, Dublin.

W. E. STEELE, M.D., Secretary *pro tem.*

BISULPHIDE OF CARBON,

CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,

161, 162, 163, PALMERSTON BUILDINGS, LONDON, E.C.

CHEMICAL LABORATORY,

WIESBADEN, GERMANY.

Director—Prof. R. FRESENIUS, Ph.D.

LECTURES.

Experimental Chemistry (Inorganic)..Prof. R. FRESENIUS, Ph.D.
Experimental Physics .. .. W. FRESENIUS, Ph.D.
Organic Chemistry } .. .. .. H. FRESENIUS, Ph.D.
Theoretical Chemistry }
Chemical Technology .. .. E. BORGMANN, Ph.D.
Mineralogy .. .. F. HENRICH.
Microscopy, with exercises in microscopic work .. .. } E. BORGMANN, Ph.D.
Practical Instruction in the Laboratory .. .. { Prof. R. FRESENIUS, Ph.D., H. FRESENIUS, Ph.D., and two Assistants.

The next Session commences on the 15th of October. The Regulations of the Laboratory and the Syllabus of Lectures will be forwarded gratis on application to C. W. KREIDEL'S Verlag, at Wiesbaden, or to the undersigned.

Prof. R. FRESENIUS, Ph.D.

SPECIALITIES.

MANGANESE—Finest Crystallised, Lump, Ground, and Granulated of every quality, and PREPARED for *Chlorine*, *Glass*, *Steel*, *Ferro-Manganese*, *Pottery*, *Battery*, and EVERY PURPOSE.

BAUXITE—(Hydrate of Alumina) Of high percentage of Alumina and almost free from Iron. The CHEAPEST, BEST, and MOST PROFITABLE article from which to produce ALUM, ALUM CAKE, and SULPHATE OF ALUMINA, &c.
[BRAND, "IRISH HILL BAUXITE."]

FLUOR-SPAR—Of the Very Finest Quality for Acid, Soda, Glass Flux, and all purposes.

BARYTES—(Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

CRYOLITE—Magnesite, Felspar, Arsenic, Phosphates, French Chalk, Strontia, Wolfram, Chromic, Terra Alba, Rotten Stone, China Clay, Umbers Ochres, Antimony, Calamine, Emery Stone all Oxides, and all

FULLER'S EARTH—Of superior quality, and entirely free from grit. [BRAND, "EMERALD."]

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,

MINE PROPRIETOR,

Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.

OFFICES—26 CHAPEL STREET, LIVERPOOL.

Fletcher's SOLID FLAME Burner.

Will with equal ease boil an egg in a small tin saucepan, or melt half-a-hundredweight of lead in an iron pot. It will boil half-a-gallon of water in a flat copper kettle in six minutes, and will melt 6 lbs. of lead or solder in an iron ladle in seven minutes. Price, Japanned, 4s.; nickel plated, 5s. Complete list of GAS FURNACES for all purposes; Hot and Cold Blast BLOWPIPES; Automatic, Foot, and Hand BLOWING APPARATUS; INSTANTANEOUS WATER HEATERS, &c., Price 3d., post free, with reprint of Mr. Fletcher's paper on the application of gaseous fuel to laboratory work, to which was awarded the Silver Medal of the Society of Arts.

THOS. FLETCHER,

4 & 6, MUSEUM STREET, WARRINGTON.

SILICATE OF SODA, Solid and in Solutions of Various Degrees of Concentration: the finest quality obtainable, and especially adapted for the use of Soap Makers and other Consumers.—JOSEPH CROSFIELD and SONS, Soap Makers, &c., Warrington.

London Agent—H. B. CLARKE 37, Great Tower Street, E.C.

THE CHEMICAL NEWS.

Vol. XLII. No. 1084.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.

By J. H. GILBERT, Ph.D., F.R.S., V.P.C.S., F.L.S., President of the Section.

Some of my predecessors in this Chair, whose duties as teachers of chemistry lead them to traverse a wide range of the subject every year, have appropriately and usefully presented to the Section a *résumé* of the then recent progress in the manifold branches of the science which have now such far-reaching ramifications. Such a course has, however, come to be of much less importance and interest of late years since the systematic publication by the Chemical Society of abstracts of chemical papers in home and foreign journals as soon as possible after their appearance. Some, on the other hand, have confined attention to some department with which their own enquiries have more specially connected them. And, when the Council of the Association request a specialist like myself to undertake the Presidency of the Section, it is to be supposed that they take it for granted that he will select for his opening address some branch of the subject with which he is known to be mainly associated.

But it seems to me that there is a special reason why I should bring the subject of Agricultural Chemistry before you on the present occasion. Not only is the application of chemistry to agriculture included in the title of this Section; but in 1837 the Committee of the Section requested the late Baron Liebig to prepare a report upon the then condition of Organic Chemistry, and it is now exactly forty years since Liebig presented to the British Association the first part of his report, which was entitled "Organic Chemistry in its Applications to Agriculture and Physiology"; and the second part was presented two years later, in 1842, under the title of "Animal Chemistry, or Organic Chemistry in its Application to Physiology and Pathology." Yet, so far as I am aware, no President of the Section has, from that time to the present, taken as the subject of his address the Application of Chemistry to Agriculture.

Appropriate as, for these reasons, it would seem that I, who have devoted a very large portion of the interval since the publication of Liebig's works, above referred to, to agricultural enquiries, should occupy the short time that can be devoted to such a purpose in attempting to note progress on that important subject, it will be readily understood that it would be quite impossible to condense into the limits of an hour's discourse anything approaching to an adequate account, either of the progress made during the last forty years, or of the existing condition of agricultural chemistry.

For what is agricultural chemistry? It is the chemistry of the atmosphere; the chemistry of the soil; the chemistry of vegetation; and the chemistry of animal life and growth. And but a very imperfect indication of the amount of labour which has been devoted of recent years to the investigation of these various branches of what might at first sight seem a limited subject will suffice to convince you how hopeless a task it would be to seek to do more than direct attention to a few points of special interest. Indeed, devoting to the purpose such leisure as I have been able to command, the more I have attempted to become acquainted with the vast literature which has been accumulated on the subject, the more difficulty have I felt in making a selection of illustrations which should not convey an idea of the limits, rather than of the extent, of the labour which has been expended, and of the results which had been attained, in agricultural research.

The works of Liebig to which I have referred have, as you all know, been the subject of a very great deal of controversy. Agricultural chemists, vegetable physiologists, and animal physiologists have each vehemently opposed some of the conclusions of the author, bearing upon their respective branches. But if the part which has fallen to my own lot in these discussions qualifies me at all to speak for others as well as myself, I would say that those who, having themselves carefully investigated the points in question, have the most prominently dissented from any special views put forward in those works, will—whether they be agricultural chemists, vegetable physiologists, or animal physiologists—be the first to admit how vast has been the stimulus, and how important has been the direction, given to research in their own department, by the masterly review of then existing knowledge, and the bold, and frequently sagacious, generalisations of one of the most remarkable men of his time!

Confining attention to researches bearing upon agriculture, it will be well, before attempting to indicate either the position established by Liebig's first works, or the direction of the progress since made, to refer very briefly to the early history of the subject.

From what we now know of the composition and of the sources of the constituents of plants, it is obvious that a knowledge of the composition of the atmosphere and of water was essential to any true conception of the main features of the vegetative process; and it is of interest to observe that it was almost simultaneously with the establishment, towards the end of the last century, of definite knowledge as to the composition of the air and of water, that their mutual relations with vegetation were first pointed out. To the collective labours of Black, Scheele, Priestly, Lavoisier, Cavendish, and Watt, we owe the knowledge that common air consists chiefly of nitrogen and oxygen, with a little carbonic acid: that carbonic acid is composed of carbon and oxygen; and that water is composed of hydrogen and oxygen; whilst Priestly and Ingenhousz, Sennebier and Woodhouse, investigated the mutual relations of these bodies and vegetable growth. Priestly observed that plants possessed the faculty of purifying air vitiated by combustion or by the respiration of animals; and, he having discovered oxygen, is was found that the gaseous bubbles which Bonnet had shown to be emitted from the surface of leaves plunged in water consisted principally of that gas. Ingenhousz demonstrated that the action of light was essential to the development of these phenomena; and Sennebier proved that the oxygen emitted resulted from the decomposition of the carbonic acid taken up.

So far, however, attention seems to have been directed more prominently to the question of the influence of plants upon the media with which they were surrounded, than to that of the influence of those media in contributing to the increased substance of the plants themselves. Towards the end of the last century, and in the beginning of the present one, De Saussure followed up these enquiries; and in his work entitled "Recherches Chimiques sur la Végétation," published in 1804, he may be said to have indicated, if not indeed established, some of the most important facts with which we are yet acquainted regarding the sources of the constituents stored up by the growing plant. De Saussure illustrated experimentally, and even to some extent quantitatively, the fact that in sunlight plants increase in carbon, hydrogen, and oxygen, at the expense of carbonic acid and of water; and in the case of his main experiment on the point, he found the increase in carbon, and in the elements of water, to be very closely in the proportion in which these are known to exist in the carbohydrates. He further maintained the essentialness of the mineral or ash constituents of plants; he pointed out that they must be derived from the soil; and

he called attention to the probability that the incombustible constituents so derived by plants from the soil were the source of those found in the animals fed upon them.

With regard to the nitrogen which plants had already been shown to contain, Priestly and Ingenhousz thought their experiments indicated that they absorbed free nitrogen from the atmosphere; but Sennebier and Woodhouse arrived at an opposite conclusion. De Saussure, again, thought that his experiments showed rather an evolution of nitrogen at the expense of the substance of the plant than any assimilation of it from gaseous media. He further concluded that the source of the nitrogen of plants was more probably the nitrogenous compounds in the soil, and the small amount of ammonia which he demonstrated to exist in the atmosphere.

Upon the whole, De Saussure concluded that air and water contributed a much larger proportion of the dry substance of plants than did the soils in which they grew. In his view a fertile soil was one which yielded liberally to the plant nitrogenous compounds, and the incombustible or mineral constituents; whilst the carbon, hydrogen, and oxygen, of which the greater proportion of the dry substance of the plant was made up, were at least mainly derived from the air and water.

Perhaps I ought not to omit to mention here that, each year for ten successive years, 1802 to 1812, Sir Humphry Davy delivered a course of lectures on the "Elements of Agricultural Chemistry," which were first published in 1813, were finally revised by the author for the Fourth Edition in 1827, but have gone through several editions since. In those Lectures, Sir Humphry Davy passed in review and correlated the then existing knowledge, both practical and scientific, bearing upon agriculture. He treated of the influences of heat and light; of the organisation of plants; of the difference, and the change, in the chemical composition of their different parts; of the sources, composition, and treatment of soils; of the composition of the atmosphere, and its influence on vegetation; of the composition and the action of manures; of fermentation and putrefaction; and, finally, of the principles involved in various recognised agricultural practices.

With the exception of these discourses of Sir Humphry Davy, the subject seems to have received comparatively little attention, nor was any important addition made to our knowledge in regard to it during the period of about thirty years from the date of the appearance of De Saussure's work in 1804 to that of the commencement of Boussingault's investigations.

About 1834, Boussingault became, by marriage, joint proprietor with his brother-in-law of the estate of Bechelbronn, in Alsace. His brother-in-law, M. Lebel, was both a chemical manufacturer and an intelligent practical farmer, accustomed to use the balance for the weighing of manures, crops, and cattle. Boussingault seems to have applied himself at once to chemico-agricultural research; and it was under these conditions of the association of "practice with science" that the first laboratory on a farm was established.

From this time forward, Boussingault generally spent about half the year in Paris, and the other half in Alsace; and he has continued his scientific labours, sometimes in the city, and sometimes in the country, up to the present time. His first important contribution to agricultural chemistry was made in 1836, when he published a paper on the amount of nitrogen in different foods, and on the equivalence of the foods, founded on the amounts of nitrogen they contained; and he compared the results so arrived at with the estimates of others founded on actual experience. Although his conclusions on the subject have doubtless undergone modification since that time, the work itself marked a great advance on previously existing knowledge, and modes of viewing the question.

In 1837, Boussingault published papers—on the amount of gluten in different kinds of wheat, on the influence of the clearing of forests on the diminution of the flow of rivers, and on the meteorological influences affecting the culture of the vine. In 1838 he published the results of an elaborate research on the principles underlying the value of a rotation of crops. He determined by analysis the composition, both organic and inorganic, of the manures applied to the land, and of the crops harvested. In his treatment of the subject he evinced a clear perception of the most important problems involved in such an enquiry; some of which, with the united labours of himself and many other workers, have scarcely yet reached an undisputed solution.

Thus, in the same year (1838), he published the results of an investigation on the question whether plants assimilate the free or uncombined nitrogen of the atmosphere; and although the analytical methods of the day were inadequate to the decisive settlement of the point, his conclusions were in the main those which much subsequent work of his own, and much of others also, has served to confirm.

As a further element of the question of the chemical statistics of a rotation of crops, Boussingault determined the amount and composition of the residues of various crops; also the amount of constituents consumed in the food of a cow and of a horse respectively, and yielded in the milk and excretions of the cow, and in the excretions of the horse. Here, again, the exigencies of the investigation he undertook were beyond the reach of the known methods of the time. Indeed, rude as the art of agriculture is generally considered to be, the scientific elucidation of its practices requires the most refined, and very varied, methods of research; and a characteristic of the work of Boussingault may be said to be that he has frequently had to devise methods suitable to his purpose before he could grapple with the problems before him.

In 1839, chiefly in recognition of his important contributions to agricultural chemistry, Boussingault was elected a member of the Institute; and in 1878, thirty-nine years later, the Council of the Royal Society awarded to him the Copley Medal, the highest honour at their disposal, for his numerous and varied contributions to science, but especially for those relating to agriculture.

The foregoing brief historical sketch is sufficient to indicate, though but in broad outline, the range of existing knowledge on the subject of agricultural chemistry prior to the appearance of Liebig's memorable work in 1840. It will be seen that some very important and indeed fundamental facts had already been established in regard to vegetation, and that Boussingault had not only extended enquiry on that subject, but he had brought his own and previous results to bear upon the elucidation of long recognised agricultural practices. There can be no doubt that the data supplied by his researches contributed important elements to the basis of established facts upon which Liebig founded his brilliant generalisations. Accordingly, in 1841, Dumas and Boussingault published, jointly, an essay which afterwards appeared in English under the title of "The Chemical and Physiological Balance of Organic Nature"; and, in 1843, Boussingault published a larger work, which embodied the results of many of his own previous original investigations.

But there can be no doubt that the appearance of Liebig's two works, which were contributions made in answer to a request submitted to him by the committee of this Section of the British Association, constituted a very marked epoch in the history of the progress of agricultural chemistry. In the treatment of his subject he not only called to his aid the previously existing knowledge directly bearing upon it, but he also turned to good account the more recent triumphs of organic chemistry, many of which had been won in his own laboratory. Further, a marked feature of his expositions was the adoption of what might be called the *statistical* method—I use the word statistical rather than quantitative, as the latter expression has its own technical meaning among chemists, which is not precisely what I wish to convey.

It seems that, notwithstanding the conclusive evidence afforded by the direct experiments of De Saussure and his

predecessors, vegetable physiologists continued to hold the view that the humus of the soil was the source of the carbon of vegetation. Not only did Liebig give full weight to the evidence of the experiments of De Saussure and others, and illustrate the possible and probable transformations within the plant by facts already established in organic chemistry, but he demonstrated the utter impossibility of humus supplying the amount of carbon assimilated over a given area. He pointed out that humus itself was the product of previous vegetable growth, and that it could not therefore be an original source of carbon; and that, from the degree of its insolubility, either in pure water or in water containing alkaline or earthy bases, only a small fraction of the carbon assimilated by plants could be derived from the amount of humus that could possibly enter the plant in solution. He maintained that, so far as humus was beneficial to vegetation at all, it was only by its oxidation, and a consequent supply of carbonic acid within the soil; a source which he considered only of importance in the early stages of the life of a plant, and before it had developed and exposed a sufficient amount of green surface to the atmosphere to render it independent of soil supplies of carbonic acid.

With regard to the hydrogen of plants, at any rate that portion of it contained in their non-nitrogenous products, he maintained that its source must be water; and that the source of the oxygen was either that contained in carbonic acid or that in water.

With regard to the nitrogen of vegetation, both from the known characters of free nitrogen, and as he considered a legitimate deduction from direct experiments, he argued that plants did not take up free or uncombined nitrogen, either from the atmosphere, or dissolved in water and so absorbed by the roots. The source of the nitrogen of vegetation was, he maintained, ammonia; the product of the putrefaction of one generation of plants and animals supplying the ammonia for the next. He pointed out that, in the case of a farm receiving nothing from external sources, and selling off certain products, the amount of nitrogen in the manure derived by the consumption of some of the vegetable produce on the farm itself, together with that due to the refuse of the crops, must always be less than was contained in the crops grown; and he concluded that though the quantity so returned to the land was important, a main source of the nitrogen assimilated over a given area was that brought down from the atmosphere in rain.

There can be no doubt that, owing to the limited and defective experimental evidence then at command on the point, Liebig at that time (as he has since) greatly overestimated the amount of ammonia available to vegetation from that source. In Boussingault's "*réclamation*" already referred to, he gave much more prominence to the importance of the nitrogen of manures. In Liebig's next edition (in 1843) he combatted the notion of the relative importance of the nitrogen of manures; maintained, in opposition to the view put forward in his former edition, that the atmosphere afforded a sufficient supply of nitrogen for cultivated as well as for uncultivated plants; that the supply was sufficient for the cereals as well as for leguminous plants; that it was not necessary to supply nitrogen to the former; and he insisted very much more strongly than formerly on the relative importance of the supply of the incombustible, or, as he designated them, the "inorganic" or "mineral" constituents.

As to the incombustible or mineral constituents themselves, Liebig adduced many illustrations in proof of their essentialness. He called attention to the variation in the composition of the ash of plants grown on different soils; and he assumed a greater degree of mutual replaceability of one base by another, or of one acid by another, than could be now admitted. He traced the difference in the mineral composition of different soils to that of the rocks which had been their source; and he seems to have been led by the consideration of the gradual action of "weathering," in rendering available the otherwise locked-up stores, to attribute the benefits of fallow exclusively to the increased supply of the incombustible constituents which would by its agency be brought into a condition in which they could be taken up by plants.

The benefits of an alteration of crops Liebig considered to be in part explained by the influence of the excreted matters from one description of crop upon the growth of another. He did not attach weight to the assumption that such matters would be directly injurious to the same description of crop; but he supposed rather that the matters excreted were those which the plant did not need, and would therefore be of no avail to the same description of plant, but would be of no use to another. He, however, attributed much of the benefits of a rotation to different mineral constituents being required from the soil by the respective crops.

Treating of manure, he laid the greatest stress on the return by it of the potass and the phosphates removed by the crops. But he also insisted on the importance of the nitrogen, especially that in the liquid excretions of animals, and condemned the methods of treatment of animal manures by which the ammonia was allowed to be lost by evaporation. It is curious and significant, however, that some of the passages in his first edition, in which he the most forcibly urges the value of the nitrogen of animal manures, are omitted in the third and fourth editions.

The discussion of the processes of fermentation, decay, and putrefaction, and that of poisons, contagions, and miasms, constituted a remarkable and important part of Liebig's first report. It was the portion relating to poisons, contagions, and miasms, that he presented to this Section as an instalment, at the meeting of the Association held at Glasgow in 1840. It was in the chapters relating to the several subjects here enumerated that he developed so prominently his views on the influence of contact in inducing chemical changes. He cited many known transformations, other than those coming under either of the heads in question, in illustration of his subject: and he discussed with great clearness the different conditions occurring, and the different results obtained, in various processes—such as the different modes of fermenting beer, the fermentation of wine from different kinds of grapes, the production of acetic acid, &c. As is well known, he claimed a purely chemical explanation for the phenomena involved in fermentation. He further maintained that the action of contagions was precisely similar. In his latest writings on the subject (in 1870), he admits some change of view; but it is by no means easy to decide exactly how much or how little of modification he would wish to imply.

Liebig's second report, presented at the meeting of this Association in 1842, and published under the title of "Animal Chemistry, or Organic Chemistry in its applications to Physiology and Pathology," perhaps excited even more attention than his first; and, probably from the manner as much as from the matter, aroused a great deal of controversy, especially among physiologists and physicians. Liebig was severe upon what he considered to be a too exclusive attention to morphological characters in physiological research, and at any rate too little attention to chemical phenomena, and, so far as these were investigated, an inadequate treatment of the subject according to strictly quantitative methods.

He combatted the view that nervous action, as such, could be a source of any of the heat of the body; and he adduced numerous illustrations and calculations in support of the view that the combustion of carbon and hydrogen in the system was sufficient to account for, and was the only source of, animal heat.

He compared and contrasted the general composition of plants and animals. In accordance with Mulder, he pointed out that whilst plants formed the nitrogenous bodies which they contain from carbonic acid, water, and ammonia, animals did not produce them, but received them ready-formed in their vegetable food; that, in fact,

the animal begins only where the plant ends. But, going beyond Mulder, and beyond what had then, or has since, been established, he maintained the identity in composition of the admittedly analogous nitrogenous compounds in plants and in the blood of animals.

Omitting the fat which the carnivora might receive in the animals they consumed, he stated the characteristic difference between the food of carnivora and herbivora to be, that the former obtained the main proportion of their respiratory material from the waste of tissue; whilst the latter obtained a large amount from starch, sugar, &c. These different conditions of life accounted for the comparative leanness of carnivora and fatness of herbivora.

He maintained that the vegetable food consumed by herbivora did not contain anything like the amount of fat which they stored up in their bodies; and he showed how nearly the composition of fat was obtained by the simple elimination of so much oxygen, or of oxygen and a little carbonic acid, from the various carbohydrates. Much less oxygen would be required to be eliminated from a quantity of fibrine, &c., containing a given amount of carbon than from a quantity of carbohydrates containing an equal amount of carbon. The formation of fatty matter in plants was of the same kind; it was the result of a secondary action, starch being first formed from carbonic acid and water.

He concluded from the facts adduced that the food of man might be divided into the *nitrogenised* and the *non-nitrogenised* elements. The former were capable of conversion into blood, the latter incapable of such transformation. The former might be called the *plastic elements of nutrition*, the latter *elements of respiration*. From the plastic elements, the membranes and cellular tissue, the nerves and brain, cartilage, and the organic part of bones, could be formed; but the plastic substance must be received ready-made. Whilst gelatine or chondrine was derived from fibrine or albumen, fibrine or albumen could not be re-produced from gelatine or chondrine. The gelatinous tissues suffer progressive alteration under the influence of oxygen, and the materials for their re-formation must be restored from the blood. It might, however, be a question whether gelatine taken in food might not again be converted into cellular tissue, membrane, and cartilage, in the body.

At that time, adopting and attaching great importance to Mulder's views in regard to proteine, he says:—"All the organic nitrogenised constituents of the body, how different soever they may be in composition, are derived from proteine. They are formed from it by the addition or subtraction of the element of water or of oxygen, and by re-solution into two or more compounds."

He seeks to trace the changes occurring in the conversion of the constituents of food into blood, of those of blood into the various tissues, and of these into the secretions and excretions.

He states that the process of chymification takes place in virtue of a purely chemical action, exactly similar to those processes of decomposition or transformation which are known as putrefaction, fermentation, or decay. Thus, the clear gastric juice contains a substance in a state of transformation, by the contact of which with the insoluble constituents of the food they are rendered soluble, no other element taking any share in the action excepting oxygen and the elements of water. All substances which can arrest the phenomena of fermentation and putrefaction in liquids also arrest digestion when taken into the stomach. Putrefying blood, white of egg, flesh, and cheese, produce the same effects in a solution of sugar as yeast or ferment; the explanation being that ferment, or yeast, is nothing but vegetable fibrine, albumen, or caseine, in a state of decomposition.

Referring to the derivation of the animal tissues, he says they all contain, for a given amount of carbon, more oxygen than the nitrogenous constituents of blood. In hair and gelatinous membrane there is also an excess of nitrogen and hydrogen, and in the proportions to form ammonia. We may suppose an addition of these elements, or a subtraction of carbon, the amount of nitrogen remaining the same. The gelatinous substance is not a compound of proteine; it contains no sulphur, no phosphorus; and it contains more nitrogen, or less carbon, than proteine.

He next, as he says, attempts to develop analytically the principal metamorphoses which occur in the animal body. He adds that the results have surprised himself no less than they will others, and have excited in his own mind the same doubts as others will conceive. He nevertheless gives them, because he is convinced that the method by which they have been obtained is the only one by which we can hope to acquire an insight into the nature of organic processes.

Referring to the animal secretions, he argues that they must contain the products of the metamorphosis of the tissues. He says a starving man with severe exertion secretes more urea than the most highly fed individual in a state of rest; and he combats the idea that the nitrogen of the food can pass into urea without having previously become part of an organised tissue.

Having shown the chemical relations of bile and urine to the proteine bodies, he illustrates, by formulæ, the connection between allantoine and the constituents of the urine of animals that respire. He insists that in the herbivora the carbohydrates must take part in the formation of bile; and he calculates the number of equivalents of proteine, starch, oxygen, and water, which would yield a given number of equivalents of urea, choleic acid, ammonia, and carbonic acid. The non-nitrogenous constituents in the food of the herbivora retard the the metamorphosis of the nitrogenous bodies, rendering this less rapid than in the carnivora. It may be said that proteine, starch, and oxygen give the secretions and excretions, carbonic acid by the lungs, urea and carbonate of ammonia by the kidneys, choleic acid by the liver. It is the study of the phenomena which accompany the metamorphoses of the food in the organism, the discovery of the share which the atmosphere and the elements of water take in these changes, by which we shall learn the conditions necessary for the production of a secretion or of an organised part.

He traces the possible formation of taurine from caffeine or asparagine by their assumption of oxygen and of the elements of water. And from the composition of the vegetable alkaloids he suggests the possibility of their taking a share in the formation of new, or the transformation of existing, brain and nervous matter.

Finally, in reference to these various illustrations and considerations, he says however hypothetical they may appear, they deserve attention in so far as they point out the way which chemistry must pursue if she would really be of service to physiology and pathology. Chemistry, he says, relates to the conversion of food into the various tissues and secretions, and to their subsequent metamorphosis into lifeless compounds.

After this lapse of time, it will certainly be granted that, quite irrespectively of the admissibility or otherwise of the particular illustrations adduced, or of the truth or error of and of the conclusions drawn—and some at least are so true that they seem to us now all but truisms, and you may be disposed to ask me why I should tell you over again a story so often told before—there is no doubt that Liebig's manner of treating the subject did exert an immense influence by stimulating investigation, by fixing attention on the points to be investigated and on the methods that must be followed, and thus by leading to the establishment or the correction of any special views he put forward, and to a vast extension of our knowledge on the complicated questions involved.

In the third part of Liebig's second volume he treats of the phenomena of motion in the animal organism. It is to his views in regard to one aspect only of this very wide and very complicated subject that I propose to call your attention here, as it is chiefly in so far as that aspect is concerned that the question is of interest from the point of view of the agricultural chemist. He says:—

"We observe in animals that the conversion of food into blood, and the contact of the blood with the living tissues, are determined by a mechanical force, whose manifestation proceeds from distinct organs, and is effected by a distinct system of organs, possessing the property of communicating and extending the motion which they receive. We find the power of the animal to change its place and to produce mechanical effects by means of its limbs dependent on a second similar system of organs or apparatus."

He points out that the motion of the animal fluids proceeds from distinct organs (as, for example, that of the blood from the heart), which do not generate the force in themselves, but receive it from other parts by means of the nerves: the limbs also receive their moving force in the same way. He adds:—"Where nerves are not found motion does not occur." Again:—

"As an immediate effect of the manifestation of mechanical force, we see that a part of the muscular substance loses its vital properties, its character of life; that this portion separates from the living part, and loses its capacity of growth and its power of resistance. We find that this change of properties is accompanied by the entrance of a foreign body (oxygen) into the composition of the muscular fibre . . .; and all experience proves that this conversion of living muscular fibre into compounds destitute of vitality is accelerated or retarded according to the amount of force employed to produce motion." He adds that a rapid transformation of muscular fibre determines a greater amount of mechanical force, and that conversely a greater amount of mechanical motion determines a more rapid change of matter.

"The change of matter, the manifestation of mechanical force, and the absorption of oxygen, are, in the animal body, so closely connected with each other that we may consider the amount of motion and the quantity of living tissue transformed as proportional to the quantity of oxygen inspired and consumed in a given time by the animal." Again:—

"The production of heat and the change of matter are closely related to each other; but although heat can be produced in the body without any change of matter in living tissues, yet the change of matter cannot be supposed to take place without the co-operation of oxygen."

Further, on the same point:—"The sum of force available for mechanical purposes must be equal to the sum of the vital forces of all tissues adapted to the change of matter. If, in equal times, unequal quantities of oxygen are consumed, the result is obvious in an unequal amount of heat liberated, and of mechanical force. When unequal amounts of mechanical force are expended, this determines the absorption of corresponding and unequal quantities of oxygen."

Then, more definitely still, referring to the changes which take place coincidently with the exercise of force, and to the demands of the system for repair accordingly, he says:—

"The amount of azotised food necessary to restore the equilibrium between waste and supply is directly proportional to the amount of tissues metamorphosed. The amount of living matter, which in the body loses the condition of life, is, in equal temperatures, directly proportional to the mechanical effects produced in a given time. The amount of tissue metamorphosed in a given time may be measured by the quantity of nitrogen in the urine. The sum of the mechanical effects produced in two individuals, in the same temperature, is proportional to the amount of nitrogen in their urine, whether the mechanical force has been employed in the voluntary or involuntary motions, whether it has been consumed by the limbs, or by the heart and other viscera."

Thus, apparently influenced by the physiological considerations which have been adduced, and notwithstanding in some passages he seemed to recognise a connection between the total quantity of oxygen inspired and consumed and the quantity of mechanical force developed, Liebig nevertheless very prominently insisted that the amount of muscular tissue transformed—the amount of nitrogenous substance oxidated—was the measure of the force generated. He accordingly distinctly draws the conclusion that the requirement for the azotised constituents of food will be increased in proportion to the increase in the amount of force expended.

It will be obvious that the question whether in the feeding of animals for the exercise of mechanical force, that is, for their labour, the demands of the system will be proportionally the greater for an increased supply of the nitrogenous or of the non-nitrogenous constituents of food, is one of considerable interest and practical importance. To this point I shall have to refer further on.

So far, I have endeavoured to convey some idea of the state of knowledge on the subject of the chemistry of agriculture prior to the appearance of Liebig's first two works bearing upon it, and also briefly to summarise the views he then enunciated in regard to some points of chief importance. Let us next try to ascertain something of the influence of his teaching.

Confining attention to agricultural research, it may be observed that about the year 1843, that is, very soon after the appearance of the works in question, there was established the Chemico-Agricultural Society of Scotland, which was, I believe, broken up, after it had existed about five years, because its able chemist, the late Professor Johnston, was unable to find a remedy for the potato disease. Shortly after this, the Highland and Agricultural Society of Scotland appointed a consulting chemist; somewhat later the Royal Agricultural Society of England did the same; and later still followed the Chemico-Agricultural Society of Ulster. Lastly, the very numerous "Agricultural Experimental Stations" which have been established, not only in Germany, but in most Continental States, owe their origin directly to the writings, the teachings, and the influence of Liebig. The movement seems to have originated in Saxony, where Stöckhardt had already stimulated interest in the subject by his lectures and his writings. After some correspondence, in 1850-1, between the late Dr. Crucius and others on the one side, and the Government on the other, the first so-called Agricultural Experimental Station was established at Möchern, near Leipzig, 1851-2. In 1877, the twenty-fifth anniversary of the foundation of that institution was celebrated at Leipzig, when an account (which has since been published) was given of the number of stations then existing, of the number of chemists engaged, and of the subjects which had been investigated. From that statistical statement we learn that in 1877 the number of stations was:—

In the various German States ..	74
In Austria	16
In Italy	10
In Sweden	7
In Denmark	1
In Russia	3
In Belgium	3
In Holland	2
In France	2
In Switzerland	3
In Spain	1
Total	122

Besides these 122 stations on the Continent of Europe, the United States are credited with 1, and Scotland also with 1.

Each of these stations is under the direction of a chemist, frequently with one or more assistants. One special duty of most of them is what is called manure-, or seed-, or feeding-stuff-control; that is, to examine or analyse, and report upon such substances in the market, and it seems to have been found the interest of dealers in these commodities to submit their proceedings to a certain

degree of supervision by the chemist of the station of their district.

But agricultural research has also been a characteristic feature of these institutions. It is stated that the investigation of soils has been the prominent object at 16 of them; experiments with manures at 24; vegetable physiology at 28; animal physiology and feeding experiments at 20; vine culture and wine making at 13; forest culture at 9; and milk production at 11. Others, according to their locality, have devoted special attention to fruit culture, olive culture, the cultivation of moor, bog, and peat land, the production of silk, the manufacture of spirit, and other products.

Nor does this enumeration of the institutions established as the direct result of Liebig's influence, and of the subjects investigated under their auspices, complete the list either of the workers engaged, or of the work accomplished in agricultural research. To say nothing of the labours of Boussingault, which commenced some years prior to the appearance of Liebig's first work, and which are fortunately still at the service of agriculture, important contributions have been made by the late Professors Johnston and Anderson in Scotland, and in this country both by Mr. Way and Dr. Voelcker, each alike in his private capacity, and in fulfilment of his duties as Chemist to the Royal Agricultural Society of England. Nor would it be fair to Mr. Lawes (who commenced experimenting first with plants in pots, and afterwards in the field, soon after entering into possession of his property in 1834, and with whom I have myself been associated since 1843), were I to omit in this place any mention of the investigations which have been so many years in progress at Rothamsted.

So much for the machinery; but what of the results achieved by all this activity in the application of chemistry to agriculture?

As I have already intimated, and as the foregoing brief statistical statement will have convinced you must be the case, it will be utterly impossible to give, on such an occasion as this, anything approaching to an adequate review of the progress achieved. Indeed, I have to confess that the more I have looked at the subject with the hope of treating it comprehensively, the more I have been impelled to substitute a very limited plan for the much more extended scheme which I had at first hoped to be able to fill up. I propose then to confine attention to a few special points, which have either some connection with one another, or to which recent results or discussions lend some special interest.

First as to the sources and the assimilation of the carbon, the hydrogen, and the oxygen of vegetation. From the point of view of the agricultural chemist, the hydrogen and the oxygen may be left out of view. For, if the cultivator provide to the plant the conditions for the accumulation of sufficient nitrogen and carbon, he may leave it to take care of itself in the matter of hydrogen and oxygen. That the hydrogen of the carbo-hydrates is exclusively obtained from water is, to say the least, probable: and whether part of their oxygen is derived from carbonic acid, and part from water, or the whole from either of these, will not affect his agricultural practice.

With regard to the carbon, the whole tendency of subsequent observations is to confirm the opinion put forward by De Saussure about the commencement of the century, and so forcibly insisted upon by Liebig forty years later—that the greater part, if not the whole of it, is derived from the carbonic acid of the atmosphere. Indeed, direct experiments are not wanting—those of Moll, for example—from which it has been concluded that plants do not even utilise the carbonic acid which they may take up from the soil by their roots. However this may be, we may safely conclude that practically the whole of the carbon which it is the object of the cultivator to force the plants he grows to take up is derived from the atmosphere, in which it exists in such extremely small proportion, but nevertheless large actual, and constantly renewed amount.

Judging from the more recent researches on the point, it would seem probable that the estimate of one part of carbon, as carbonic acid, in 10,000 of air, is more probably too high than too low as an estimate of the average quantity in the atmosphere of our globe. And, although this corresponds to several times more in the column of air resting over an acre of land than the vegetation of that area can annually take up, it represents an extremely small amount at any one time in contact with the growing plants, and could only suffice on the supposition of a very rapid renewal, accomplished as the result, on the one hand, of a constant return of carbonic acid to the atmosphere by combustion and the respiration of animals, and, on the other, of a constant interchange and equalisation among the constituents of the atmosphere.

It will convey a more definite idea of what is accomplished by vegetation in the assimilation of carbon from the atmosphere if I give, in round numbers, the results of some direct experiments made at Rothamsted, instead of making general statements merely.

In a field which has now grown wheat for thirty-seven years in succession, there are some plots to which not an ounce of carbon has been returned during the whole of that period. Yet, with purely mineral manure, an average of about 1000 pounds of carbon is annually removed from the land; and where a given amount of nitrogenous manure is employed with the mineral manure, an average of about 1500 pounds per acre per annum more is obtained; in all, an average of about 2500 pounds of carbon annually assimilated over an acre of land without any return of carbonaceous manure to it.

In a field in which barley has been grown for twenty-nine years in succession, quite accordant results have been obtained. There, smaller amounts of nitrogenous manure have been employed with the mineral manure than in the experiments with wheat above cited; but the increase in the assimilation of carbon for a given amount of nitrogen supplied in the manure is greater in the case of the barley than of the wheat.

With sugar-beet, again, larger amounts of carbon have been annually accumulated without the supply of any to the soil, but under the influence of a liberal provision of both nitrogenous and mineral manure, than by either wheat or barley.

Lastly, with grass, still larger amounts of carbon have been annually accumulated, without any supply of it by manure.

Many experiments have been made, in Germany and elsewhere, to determine the amount of the different constituents taken up at different periods of the growth of various plants. But we may refer to some made at Rothamsted long ago to illustrate the rapidity with which the carbon of our crops may be withdrawn from the atmosphere.

In 1847 we carefully took samples from a growing wheat crop, at different stages of its progress, commencing on June 21st, and in these samples the dry matter, the mineral matter, the nitrogen, &c., were determined. On each occasion the produce of two separate eighths or sixteenths of an acre was cut and weighed, so that the data were provided to calculate the amounts of the several constituents which had been accumulated per acre at each period. The result was that, whilst during little more than five weeks from June 21st, there was comparatively little increase in the amount of nitrogen accumulated over a given area, more than half the total carbon of the crop was accumulated during that period.

Numerous experiments of a somewhat similar kind, made in another season (1856)), concurred in showing that, whilst the carbon of the crop was more than doubled after the middle of June, its nitrogen increased in a much less degree over the same period.

Similar experiments were also made, in 1854 and in 1856, with beans. The general result was that a smaller proportion of both the total nitrogen and the total carbon was accumulated by the middle or end of June than in

the case of the wheat; though the actual amount of nitrogen taken up by the beans was much greater, both before and after that date. The nitrogen of this leguminous crop increased in a much greater proportion during the subsequent stages of growth than did that of the gramineous crop; but the carbon increased in a larger proportion still, three-fourths or more of the total amount of it being accumulated after the middle of June.

I should say that determinations of carbon, made in samples of soil taken from the wheat field at different periods during recent years, indicate some decline in the percentage of carbon in the soils, but not such as to lead to the supposition that the soils have contributed to the carbon of the crops. Besides the amount of carbon annually removed, there will, of course, be a further accumulation in the stubble and roots of the crops; and the reduction in the total carbon of the soil, if such have really taken place, would show that the annual oxidation within the soil is greater than the annual gain by the residue of the crops.

Large as is the annual accumulation of carbon from the atmosphere over a given area in the cases cited, it is obvious that the quantity must vary exceedingly with variation of climatal conditions. It is, in fact, several times as great in the case of tropical vegetation—that of the sugar-cane, for example. And not only is the greater part of the assimilation accomplished within a comparatively small portion of the year (varying of course according to the region), but the action is limited to the hours of daylight, whilst during darkness there is rather loss than gain.

But it is remarkable that whilst the accumulation of carbon, the chief gain of solid material, takes place under the influence of light, cell-division, cell-multiplication, increase in the structure of the plant; in other words, what, as distinguished from assimilation, vegetable physiologists designate as *growth*, takes place, at any rate chiefly, during the night, and is accompanied not with the taking up of carbonic acid and the yielding up of oxygen, but with the taking up of oxygen and the giving up of carbonic acid. This evolution of carbonic acid during darkness must obviously be extremely small, compared with the converse action during daylight, coincidentally with which practically the whole of the accumulation of solid substance is accomplished. But, as the product of the night action is the same as in the respiration of animals, this is distinguished by vegetable physiologists as the respiration of plants.

I suppose I shall be considered a heretic if I venture to suggest that it seems in a sense inappropriate to apply the term *growth* to that which is associated with actual loss of material, and that the term *respiration* should be applied to so secondary an action as that as the result of which carbonic acid is given off from the plant. It may, I think, be a question whether there is any advantage in thus attempting to establish a parallelism between animal and vegetable processes; rather would it seem advantageous to keep prominently in view their contrasted, or at any rate complementary characteristics, especially in the matter of the taking up of carbonic acid and the giving up of oxygen on the one hand, and the taking in of oxygen and the giving up of carbonic acid on the other.

But it is obvious that in latitudes where there is comparatively continuous daylight during the periods of vegetation, the two actions—designated respectively assimilation and growth—must go on much more simultaneously than where there is a more marked alternation of daylight and darkness. In parts of Norway and Sweden, for example, where, during the summer, there is almost continuous daylight, crops of barley are grown with only from six to eight weeks intervening from seed time to harvest. And Prof. Schübeler, of Christiania, after making observations on the subject for nearly thirty years, has recently described the characteristics of the vegetation developed under the influence of short summers with almost continuous light. He states that, after acclimatisation, many garden flowers increase in size and depth of colour; that there is a prevailing tinge of red in the plants of the fjelds; that the aroma of fruits is increased, and their colour well developed, but that they are deficient in sweetness; and that the development of essential oils in certain plants is greater than in the same plants grown in other latitudes. Indeed, he considers it to be an established fact that light bears the same relation to aroma as heat does to sweetness.

In connection with this question of the characters of growth under the influence of continuous light, compared with those developed with alternate light and darkness, the recent experiments of Dr. Siemens on the influence of electric light on vegetation are of considerable interest.

In one series of experiments he kept one set of plants entirely in the dark; a second he exposed to electric light only; a third to daylight only; and a fourth to daylight, and afterwards to electric light from 5 to 11 p.m. Those kept in the dark acquired a pale yellow colour, and died; those exposed to electric light only maintained a light green colour, and survived; those exposed to daylight were of a darker green colour, and were more vigorous; and, lastly, those submitted to alternate daylight and electric light, and but a few hours of darkness, showed decidedly greater vigour, and, as he says, the green of the leaf was of a dark rich hue. He concluded that daylight was twice as effective as electric light; but that nevertheless, "electric light was clearly sufficiently powerful to form chlorophyll and its derivatives in the plants."

In a second series of experiments one group of plants was exposed to daylight alone; a second to electric light during eleven hours of the night, and was kept in the dark during the day; and a third to eleven hours a day, and eleven hours electric light. The plants in daylight showed the usual healthy appearance; those in alternate electric light and darkness were for the most part of a lighter colour; and those in alternate daylight and electric light far surpassed the others in darkness of green and vigorous appearance generally.

I have carefully considered these general descriptions with a view to their bearing on the question whether the characters developed under the influence of electric light, and especially those under the influence of almost continuous light, are more prominently those of assimilation or of growth; but I have not been able to come to a decisive opinion on the point. From some conversation I had with Dr. Siemens on the subject, I gather that the characteristics were more those of dark colour and vigour than of tendency to great extension in size. The dark green colour we may suppose to indicate a liberal production of chlorophyll; but if the depth of colour was more than normal, it might be concluded that the chlorophyll had not performed its due amount of assimilation work. In regard to this point, attention may be called to the fact that Dr. Siemens refers to the abundance of the blue or actinic rays in the electric arc, conditions which would not be supposed specially to favour assimilation. On the other hand, the vigour, rather than characteristic extension in size, would seem to indicate a limitation of what is technically called growth, under the influence of the almost continuous light.

Among the numerous field experiments made at Rothamsted, we have many examples of great variation in depth of green colour of the vegetation growing on plots side by side under known differences as to manuring; and we have abundant evidence of difference of composition, and of rate of carbon-assimilation, coincidently with those different shades of colour. One or two instances will strikingly illustrate the point under consideration.

There are two plots side by side in the series of experiments on permanent grass land, each of which received during six consecutive years precisely the same amount of a mixed mineral manure, including potass, and the same amount of nitrogen in the form of ammonia salts. After those six years, one of the two plots was still manured in exactly the same way each year; whilst the other was so,

with one exception—namely, the potass was now excluded from the manure. Calculation shows that there was a great excess of potass applied during the first six years; and there was no marked diminution of produce during the five or six years succeeding the cessation of the application. But each year subsequently, up to the present time, now a period of fourteen years, or of nineteen since the exclusion of the potass, the falling off in produce has been very great.

The point of special interest is, however, that all but identically the same amount of nitrogen has been taken up by the herbage growing with the deficiency of potass as by that with the continued supply of it. The colour of the vegetation with the deficiency of potass has been very much darker green than that with the full supply of it. Nevertheless, taking the average of the eight years succeeding the first six of the exclusion of the potass, there has been nearly 400 lbs. less carbon assimilated per acre per annum; and in some of the still later years the deficiency has been very much greater than this.

We have here, then, the significant fact that an equal amount of nitrogen was taken up in both cases, that chlorophyll was abundantly produced, but that the full amount of carbon was not assimilated. In other words, the nitrogen was there, the chlorophyll was there, there was the same sunlight for both plots; but the assimilation-work was not done where there was not a due supply of potass.

Again, in the field in which barley has now been grown for twenty-nine years in succession, there are two plots which have annually received the same amount of nitrogen —the one in conjunction with salts of potass, soda, and magnesia; and the other with the same, and superphosphate of lime in addition. The plot without the superphosphate of lime always maintains a darker green colour. At any given period of growth the dry substance of the produce would undoubtedly contain a higher percentage of nitrogen; but there has been a deficient assimilation of carbon, amounting to more than 500 lbs. per acre per annum, over a period of twenty-eight years. Here again, then, the nitrogen was there, the chlorophyll was there, the sunlight was there; but the work was not done.

It may be stated generally that, in comparable cases, depth of green colour, if not beyond a certain limit, may be taken to indicate corresponding activity of carbon assimilation; but the two instances cited are sufficient to show that we may, so far as the nitrogen, the chlorophyll, and the light are concerned, have the necessary conditions for full assimilation, but not corresponding actual assimilation.

It cannot, I think, fail to be recognised that in these considerations we have opened up to view a very wide field of research, and some of the points involved we may hope will receive elucidation from the further prosecution of Dr. Siemens's experiments. He will himself, I am sure, be the first to admit that what he has already accomplished has done more in raising than in settling important questions. I understand that he proposes to submit plants to the action of the separated rays of his artificial light, and the results obtained cannot fail to be of much interest. But it is obvious that the investigation should now pass from its present initiative character to that of a strictly quantitative enquiry. We ought to know not only that, under given conditions as to light, plants acquire a deeper green colour, and attain maturity much earlier than under others, but how much matter is assimilated in each case, and something also of the comparative chemical characters of the products. As between the action of one description of light and another, and as between the greater or less continuity of exposure, we ought to be able to form a judgment whether the proper balance between assimilation on the one hand, and growth and proper maturation on the other, has been attained; whether the plants have taken up nitrogen and mineral matter, and produced chlorophyll, in a greater degree than the quantity and the quality of the light have been able to turn to account; or whether the conditions as to light have been such that the processes of transformation and growth from the reserve material provided by assimilation have not been normal, or have not kept pace with the production of that material.

(To be continued.)

A LECTURE EXPERIMENT.

By HENRY LEFFMANN, M.D.

The decomposition of steam by red-hot iron is sometimes shown as a lecture experiment, but it is quite a troublesome one. By substituting magnesium for iron, the operation can be conducted in a glass tube, and will be much more satisfactory.

A yard or so of common magnesium ribbon is placed, in folds, in a hard-glass tube, in such a way that the metal touches the glass in a number of points. One end of the tube is drawn into a pretty wide jet, the other is attached to a flask of water. Steam is produced, and allowed to flow until air is expelled, and the apparatus heated sufficiently to prevent condensation at the mouth of the jet. The metal is then strongly heated at the extreme end. After a few moments, it takes fire, burning brilliantly, and the escaping hydrogen may be lighted at the jet. It is best to keep the metal quite hot throughout. The magnesia produced is dense and crisp. It may possibly be partly hydrated, but this has not been determined. The experiment, besides being a striking one, is interesting as showing a body acting as a supporter of combustion, and becoming itself converted into a combustible.

920, Walnut Street, Philadelphia,
August 14, 1880.

ON REVERTED PHOSPHORIC ACID.

By Dr. C. F. MEYER.

The author examines Wagner's view that the reversion of phosphoric acid in ferruginous and aluminous superphosphates is occasioned by the transmutation of ferric sulphate and aluminium sulphate with monobasic calcium phosphate into calcium sulphate and acid iron and aluminium phosphates. These two compounds form in the superphosphate an insoluble precipitate consisting of ferric oxide, alumina, lime, and phosphoric acid. Dr. Meyer observed that a solution made from 10 grms. Mejillones-Guano superphosphate at 20 per cent and 1 litre water gave at once an abundant precipitate with neutral ferric sulphate. A stronger solution made from 40 grms. of the same superphosphate and 1 litre water was precipitated much more slowly and to a less extent. On the addition of water a copious precipitation of ferric phosphate soon followed.

A third experiment with a solution of 40 grms. superphosphate in 200 c.c. water was not precipitated by ferric sulphate unless diluted or heated. The action of solutions of aluminium sulphate with solutions of superphosphate was precisely similar. The author concludes that reversion begins during the manufacture of superphosphate in consequence of the reaction of ferric sulphate and aluminium sulphate with monobasic lime phosphate, aided by the heat which is evolved. Hence the manufacturer on the first examination of the product does not find the proportion of soluble phosphoric acid which he expects according to the quantity of sulphuric acid used. The subsequent reversion after the completion of the product Dr. Meyer ascribes to the simultaneous action of tribasic and monobasic calcium phosphates and ferric sulphate.

The author also examines the separation of ortho- and pyro-phosphoric acid, He converted bibasic calcium

phosphate into pyro-phosphate by ignition with the aid of a blast till the weight became constant. The salt thus obtained was decomposed with sulphuric acid, the lime removed by means of alcohol, and the solution made up to 200 c.c. Of this solution 10 c.c., on neutralisation with ammonia, yielded a perfectly clear solution on heating with ammonium acetate and uranium nitrate. On cooling, the salt which had been formed partly separated out. On heating with sodium acetate and uranium nitrate the precipitate first formed was re-dissolved. If 10 c.c. of this solution were diluted with 120 c.c. water, no precipitate was obtained with ammonium chloride, magnesium chloride, and ammonia.

One grm. of the above-mentioned biphosphate was ignited, dissolved in hydrochloric acid, the excess of acid neutralised with ammonia, and the solution made up to 200 c.c. On heating 50 c.c. of the liquid with ammonium acetate, the calcium pyrophosphate was almost entirely separated out, so that ammonia scarcely occasioned a turbidity in the filtrate. Another 50 c.c. mixed with ammonium citrate and chloride yielded no precipitation with magnesium chloride and ammonia. On heating with ammonium acetate and uranium nitrate the precipitate formed was re-dissolved with difficulty. The author will give his opinion, on a future occasion, if a quantitative separation of ortho- and pyro-phosphoric acids can be based upon these methods.—*Zeitschrift für Analytische Chemie.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 4, July 26, 1880.

Apparatus for Measuring the Combustion-heat of Gases by Detonation.—M. Berthelot.—The apparatus cannot be intelligibly described without the eight accompanying illustrations.

Solution of Chlorine in Water.—M. Berthelot.—At one and the same temperature water dissolves proportions of chlorine, which vary according to the duration of contact and the intensity of the light. The variation in the heat evolved during the solution of one and the same weight of chlorine in water are considerable, as it may range from +1·50 to 3·77 cals., the first figure answering to a simple solution, and a second to a decomposition of the water by the chlorine. The displacement of oxygen by chlorine is effected much more distinctly with hydrogen peroxide, a reaction which is explained very simply on thermo-chemical principles. The solubility of chlorine in concentrated solutions of earthy chlorides is less than in water, but increases with dilution. In concentrated hydrochloric acid chlorine dissolves much more plentifully than in water, and with a greater liberation of heat, facts which render probable the formation of a peculiar combination between chlorine and hydrochloric acid.

Successive Transformations of the Photographic Image by the Prolongation of the Luminous Action.—J. Janssen.—The author has obtained the following successive transformations:—(1) The ordinary negative image; (2) a first neutral state in which the plate becomes uniformly obscure under the action of the developing agent; (3) a positive image; (4) a second neutral state opposed to the first, in which the plate becomes uniformly light; (5) a second negative image, similar to the ordinary one, but differing from it by the intervening states through which it has passed, and by the enormous difference of luminous intensity necessary for its production; (6) a third neutral state in which the negative image of the second order has disappeared, and is succeeded by a uniform sombre tint.

Causes of Terrestrial Magnetism.—Selim Lemström.—A mathematical paper, not susceptible of useful abstraction.

An Electro-dynamic Paradox.—M. Gérard-Lescuyer.—Dynamo-electric machines, of which the Gramme machine is the most common type, are reversible, that is to say, if they are traversed by a current they produce motion, and may serve for the transmission of force. Under similar conditions magneto-electric machines with constant currents possess the same properties. But if the current produced by a dynamo-electric machine is passed into a magneto-electric machine, a novel phenomenon is produced. As soon as the circuit is closed the electro-magnetic machine sets itself in motion, and takes a regular speed in proportion to the intensity of the current which excites it; suddenly it slackens, stops, and begins to move in the opposite direction, then stops anew, and turns in the same direction as at first. It is animated with a regular alternative movement, which continues as long as does the exciting current. The author explains these phenomena by supposing that the electro-magnetic machine gives rise to a special current, which in turn traverses the dynamo-electric machine in the inverse direction, reversing the polarities of the inductors and generating a new current.

Researches on Ozone.—P. Hautefeuille and J. Chappuis.—At very elevated temperatures the transformation of oxygen into ozone and of ozone into oxygen probably obey the laws of the decomposition of homogeneous systems. At mean temperatures the decomposition of ozone is considered always complete, slowly at common temperatures, but quickly at 250°. The instability of this body is therefore comparable to that of hypochlorous acid or nitrogen chloride. But whilst the heat necessary to constitute these explosive bodies can only be acquired by a secondary simultaneous reaction, the allotropic transformation of oxygen may be determined by the electric effluve alone. The act of electrisation places momentarily oxygen in conditions analogous to those of bodies which possess the property of combining directly, or of becoming polymerised under the action of heat.

A New Isomeric Modification of Aluminium Hydroxide.—Dr. D. Tommasi.—Ordinary aluminium hydroxide, as obtained by precipitating a solution of alum with ammonia, if left to itself in presence of water for about three months, undergoes a molecular change, becoming as little soluble in acids and alkalies as ignited alumina, though still retaining its 3 mols. of water. The author designates this hydrate by the letter δ, to distinguish it from the normal hydrate, α, from gibbsite, β, and from the colloidal alumina of Graham, γ. Concentrated hydrochloric and nitric acids in excess require sixty hours to dissolve the hydrate, δ. Caustic potash, highly concentrated, requires about the same time; glacial acetic acid has scarcely any appreciable action; concentrated sulphuric acid dissolves the hydrate δ at once, but if diluted to 4 per cent it requires six days to take up even a small quantity. Normal alumina forms with its chloride an oxychloride, whilst alumina δ does not.

Observations on M. E. Bourgoin's Note on the Ultimate Action of Bromine upon Malonic Acid.—B. Petrieff.—The author points out that he obtained five years ago the results which M. Bourgoin describes on p. 121 of the present volume (see *Berichte der Deutsch. Chem. Gesells.*, viii., 730).

Molecular Heats and Volumes of the Rare Earths and of their Sulphates.—L. F. Nilson and O. Petterson.—The determinations given in this paper have been made under like conditions with chemically pure compounds, the molecular weight of which is determined in each case, and they are consequently mutually comparable. The specific heat is determined from 0° to 100° with Bunsen's

calorimeter; as the aqueous sulphates cannot bear a temperature of 100° without decomposition their specific heat has been determined at 46° to 47° in the vapour of carbon disulphide. The specific gravities have been determined by a method specially adapted to avoid the errors springing from the adhesion of air to pulverulent bodies (see Otto Petterssen "Molekular volumina," *Nov. Act. R. Soc. Scien. Upsal.*, iii., 1878). The figures given are the mean of two closely concordant determinations. M. Lecoq de Boisbaudran placed at the disposal of the authors 0·138 grm. of gallium, and M. Cleve supplied them with the purest erbia which he has hitherto obtained. The authors then give tables showing the molecular weights, specific gravities, specific heats, molecular heats, and volumes of the following oxides, glucina, alumina sapphire, chrysoberyl, scandia, gallium oxide, yttria, indium oxide, erbia, ytterbia, lanthanum oxide, didymium oxide, zirconia, cerium oxide, and thoria; the anhydrous sulphates of glucinum, aluminium, scandium, chromium, iron (ferric), gallium, yttrium, indium, lanthanum, cerium, didymium, erbium, ytterbium, and thorium, and the aqueous sulphates of glucinum, yttrium, lanthanum, cerium, didymium, erbium, and ytterbium. On subtracting from the molecular heats and volumes found for the aqueous sulphates the same values for the anhydrous sulphates, there is found a remainder expressing the molecular heat and volume of the water united to the sulphates. For 1 mol. of free water these are equal to 18, whilst in the highest case determined the molecular heat = 13·02, and the molecular volume = 12·04. The molecular heat and volume of the water combined with these sulphates are therefore diminished considerably, showing a minimum value hitherto unknown. If the isomorphous compounds, *i.e.*, those of yttrium, erbium, and ytterbium, or of lanthanum and didymium, are placed in juxtaposition we see readily that the molecular heat of compounds intimately connected by isomorphism increases simultaneously with the atomic weight of the metal, whilst the molecular volume decreases. As regards the atomicity of glucinum the numbers found are particularly important. The atomic heat of the oxygen is perfectly normal in G_2O_3. The molecular heat and volume of glucina and alumina are almost identical, so that alumina examined either as crystalline sapphire, or as an amorphous powder, and chrysoberyl, considered not as an aluminate, but as—

$$\left.\begin{matrix} Al_{\frac{2}{3}} \\ G_{\frac{1}{2}} \end{matrix}\right\} O_3$$

give values completely identical. The molecular heat and volume of glucinum sulphate, compared with the same numbers for the sulphates of aluminium, scandium, gallium, yttrium, &c., argue also in favour of the formula G_2O_3. All the physical and chemical properties of the metal, the oxide and the sulphate, confirm this opinion. Glucinum by its double sulphate, $3K_2O_2SO_2 + G_2O_6{}_3SO_2$, typical for all the metals of gadolinite and cerite appears to belong to the series of these elements, collateral with but distinct from another series of elements which form alums.

A New Fermentation of Glucose.—L. Boutroux.—The author points out that the acid described in his memoir (*Comptes Rendus*, lxxxvi., p. 605) is not the lactic, but the gluconic.

Journal für Praktische Chemie.
No. 9, 1880.

Reply to H. W. Hempel.—By H. Kolbe and E. von Meyer.*—A controversial paper relating to the comparative value of salicylic, carbolic, and benzoic acids as anti-zymotics, the authors giving the preference to the first-mentioned of these bodies. It is somewhat singular that the memoir of Herrn Hempel, here criticised, appears as far back as 1875 (*Berichte der Chem. Gesell.*, vol. viii., p. 1657).

* The word which we render "reply," is equivalent to "dressing down," "polishing off," &c., and other strong colloquialisms.

On the Oxidation of Haloid Salts.—Dr. Hans Schulze.—In this paper the author successively examines the behaviour of oxygen with the chlorides, bromides, iodides, and fluorides; the action of nascent oxygen upon the same bodies; the behaviour of oxygen with haloid salts in presence of acid anhydrides, and the reaction of such anhydrides upon haloid salts in the absence of oxygen.

Destructive Action of Woody Fibre upon Salicylic Acid.—H. Kolbe.—The attempt has been made to preserve the water-supply on board ship, by a small addition of salicylic acid. It appeared that the acid was entirely destroyed and that the water then became offensive. On further examination it was found that the salicylic acid is not absorbed by the wood, but destroyed. The result is similar if salicylic acid is added to wine in the wood.

No. 10, 1880.

Thermo-chemical Researches (Part 32).—Julius Thomsen.—In this memoir, which does not admit of useful abstraction, and which contains several illustrations of apparatus, the author investigates the formation-heat of nitrous and nitric acids, nitrogen dioxide, nitric and nitrous oxides, ammonia, the ammoniacal salts and the nitrates.

Berichte der Deutschen Chemischen Gesellschaft zu Berlin.
No. 3, 1880.

Behaviour of Iodine at High Temperatures.—V. Meyer.—Already noticed.

Chlorine.—V. Meyer and H. Züblin.—Already noticed.

Observations on Vapour-densities.—V. Meyer.—Already noticed.

Platinum Bromide.—V. Meyer and H. Züblin.—In preparing Pt_2Br_4 the authors succeeded in obtaining $PtBr_4$, which had not hitherto been produced. It is a black powder, not in the slightest deliquescent, moderately soluble in water, but much more freely in alcohol and ether.

Density of Bromine Vapour at a Yellow Heat.—V. Meyer and H. Züblin.—Already inserted.

Calorimetric Determination of Temperature.—V. Meyer.—The author concludes from his own experiments and those of Roscoe that his method for the determination of high temperatures is approximately accurate.

Potassium Leuco-sulphin-digotate and Potassium Indoxyl-sulphate.—E. Baumann and F. Tiemann.—Not suitable for abstraction.

Fittica's Fourth Nitro-phenol.—S. Natanson.—The author finds that the product obtained by Fittica's process is chiefly pure ortho-nitro-phenol.

Constitution of Phthalyl Chloride.—E. von Gerichten. Not capable of useful abstraction.

MISCELLANEOUS.

British Association for the Advancement of Science.—The following are the names of the Officers and Committee of Section B (Chemical Science Section) of the Swansea Meeting of the British Association:—

President.—Joseph Henry Gilbert, Ph.D., F.R.S.

Vice-Presidents.—I. Lowthian Bell, F.R.S.; William Crookes, F.R.S.; W. Chandler Roberts, F.R.S.; Prof. Abel, F.R.S.; Dr. J. H. Gladstone, F.R.S; A. G. Vernon Harcourt, F.R.S.; Prof. A. W. Williamson, F.R.S.

Secretaries.—Harold B. Dixon, M.A.; Dr. W. R. Eaton Hodgkinson; P. Phillips-Bedson, D.Sc.; J. M. Thomson, F.R.S E. (Recorder).

Committee.—Prof. Attfield, F.R.S.; A. H. Allen; P. Braham; R. C. Clapham; J. M. Cameron; W. Fairley F.R.S.E.; C. Le Neve Foster, D.Sc.; Prof. Carey Foster,

F.R.S.; A. E. Fletcher; G. Gladstone; Prof. A. K. Huntington; Dr. Morgan; Dr. Macadam, F.R.S.E.; Dr. Morrison; J. A. Phillips; Dr. Ronalds; Dr. W. Ramsay· M. R. D. Silva; John Spiller; Peter Spence; A. Schuster, F.R.S.; Prof. Silvanus P. Thompson; W. Thomson, F.R.S.E.; W. Weldon, F.R.S.E.

The papers brought before the Section were as follows:—

Dr. J. Pattinson.—Report of Committee on the best means for the Development of Light from Coal-gas of Different Qualities. Part II.

Walter Weldon, F.R.S.E.—On some Relations between the Atomic Volumes of Certain Elements, and the Heats of Formation of some of their Compounds.

Harold B. Dixon, M.A.—On the Influence of Water on the Union of Carbonic Oxide with Oxygen at a High Temperature.

J. Sakurai.—On Metallic Compounds containing Divalent Organic Radicals. Part I.

Prof. C. Bolton.—On the Action of Organic Acids on Minerals.

Dr. A. Schuster, F.R.S.—Report on Spectrum Analysis (Spectra of Metalloids).

Prof. A. K. Huntington.—Report on Spectrum Analysis (Ultra-violet Spectra).

J. W. Starling.—An Improved Volumetric Apparatus.

J. W. Thomas.—On the Coal Seams of the Eastern portion of the South Wales Basin and their Chemical Composition.

P. Spence.—On a New Mode for Purification of Sewage.

J. M. Cameron.—Comparison of the State of Agricultural Chemistry in England and on the Continent.

Dr. J. H. Gladstone, F.R.S.—On the Refraction Equivalents of the Diamond and various Carbon Compounds.

A. H. Allen.—On the Specific Rotatory Power of Cane and Grape Sugar.

John Spiller.—On the Identification of the Coal Tar Colours.

W. Chandler Roberts, F.R.S., and T. Wrightson.—On the Fluid Density of Bismuth.

P. Braham.—On some Crystals of Mercury Sulphate.

E. A. Parnell.—On a New Process for the Metallurgic Treatment of Complex Ores containing Zinc.

J. W. Kynaston.—On a New Process for the Production, from Aluminous Minerals containing Iron, of Aluminium Sulphate free from Iron.

W. Henderson.—A New Process for Separating Silver from Copper, in Copper Ore and Regulus.

A. H. Allen.—Further Notes on Petroleum Spirit and Allied Liquids.

A. H. Allen.—On the so-called "Normal" Solutions of Volumetric Analysis.

William Thomson, F.R.S.E.—On the Determination of the Loss of Heat in Steam Boilers arising from Incrustation.

William Thomson, F.R.S.E.—On the Identification of the Ink used in Writing Letters and Documents, as Evidence in Cases of Libel, Forgery, &c.

P. Braham.—Note on Silver Sulphate.

Major-General Scott, C.B., F.R.S.—On the Influence of Magnesia on Vegetation.

W. H. Watson.—On the Action of Oils upon Copper and Iron. Part II.

F. W. Hodges.—On Bleaching-powder Residues.

Mineral Leather.—The Eglinton Chemical Company, of 29, St. Vincent Place, Glasgow, have erected an Exhibition Tannery, in order to bring under the notice of those concerned a new method of tanning, effected not by means of tannin in any form, but of chrome. The process in question, invented and patented by Dr. Heinzerling, is said to be cheaper and more expeditious than the traditional methods of tanning, and to produce leather stronger, more durable, and pliant, and especially less pervious to moisture. About 300 chrome-tanned hides are being exhibited, some of them made into belting, harness, boots, &c.

THE JOURNAL OF SCIENCE
for SEPTEMBER (Price 1s. 6d.), includes—

Report on Scientific Societies. By Dr. C. K. Akin.
Mental Evolution. By J. Foulerton, M D., F.G.S.
A Change of Front. By J. W. Slater.
On Sound as a Nuisance.
On the Evils of Sectarian Morality, contrasted with the Benefits of the Scientific or Natural System. By S. Tolver Preston.
Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

SOUTH LONDON SCHOOL OF PHARMACY

Special advantages are offered to Private Students during the Vacation in every branch of Practical Chemistry, as applied to Manufactures, Agricultural and Commercial Products, Water, Gas, Food, &c.
For terms, personal or by letter, W. BAXTER, Secretary, Central Public Laboratory, Kennington Cross, S.E.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.
The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.
Especial facilities or persons preparing for Government and other examinations.
Private Pupils will find every convenience.
Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.
Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

COMPAGNIE GENÉRALE DES CYANURES ET PRODUITS CHIMIQUES,
29, RUE DE CHATEAUDUN, PARIS,
MANUFACTURERS OF—
CRYSTALLISED SULPHOCYANIDE OF AMMONIUM (Pure).
CRYSTALLISED SULPHOCYANIDE OF AMMONIUM (Commercial; discoloured by traces of Iron).
CRYSTALLISED SULPHOCYANIDE OF POTASSIUM (Pure).

For all particulars apply to the Office:—
29, RUE DE CHATEAUDUN, PARIS,

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.
JESSE FISHER & SON,
Phœnix Chemical Works Ironbridge.

THOMAS ADKINS & CO.,
SMETHWICK,
NEAR BIRMINGHAM
MANUFACTURERS OF SPECIALLY PREPARED RED LEAD FOR FLINT-GLASS MAKING.

ROYAL POLYTECHNIC.—Shakesperian Recitals: Scenes from "Hamlet" at 7.15 p.m. daily; and at 3.30 on Monday, Wednesday, and Saturday. Hamlet, Mr. Marlande Clarke; Ophelia, Miss H. Shea; The Queen of Denmark, Miss Eva Russell; Polonius, Mr. Heath; 1st Grave-Digger, Mr. Weatherhead. Lectures on the Phenomena of Nature, the Microscope, London, Phosphorescence, &c., &c. Ghost Entertainment, Blondin, the Wonderful Automaton. Admission, 1s.; Reserved Stalls 3s.; may be booked at all the Libraries.

PHOSPHATE OF ALUMINA.

Wanted, a Purchaser for a Large Quantity of the above, 20 per cent Phosphoric Acid.
Apply, B. C. J., 106, Queen Victoria Street, E.C.

Who can supply Regenerated Black Wad, of high percentage and, if possible, always of a uniform quality?—Address, T., 61,736, care of Messrs. Haasenstein and Vogler, Frankfort-on-the-Main.

KÖRTING BROTHERS,

ENGINEERS,

17, LANCASTER AVENUE, FENNEL STREET,

MANCHESTER.

Air Compresser.

PATENT STEAM-JET AIR COMPRESSERS for oxidising caustic alkalies and agitating liquids.

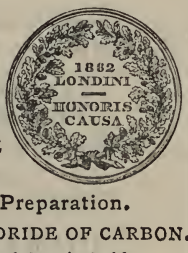
PATENT STEAM-JET EJECTORS to give a vacuum up to 27 feet of water.

SUPPLIED TO:—

The Blaydon Manure and Alkali Co., Lim.
Messrs. Brooke, Simpson, and Spiller, Hackney Wick.
Messrs. Burt, Boulton, and Haywood, Silvertown.
,, Chance, Bros., Oldbury.
,, N. and J. H. Fenner, London.
The Ford Works Co., Lim., Sunderland.
Messrs. Gaskell, Deacon, and Co., Widnes.
,, Wm. Gossage and Sons, Widnes.
,, Grimble and Co., London.
,, Hardman and Co., Manchester.
,, Holmes and Partner, Warrington.
,, Jno. Hutchinson and Co., Widnes.
The Jarrow Chemical Company, Gateshead.
Messrs. D. Martineau and Sons, London.
,, Jas. Muspratt and Sons, Widnes.
The North British Chemical Co., Dalmuir.
The Patent Sulphate Copper Company, Macclesfield.
Messrs. Jno. Riley and Sons, Hapton.
,, Roberts, Dale, and Co., Manchester.
,, Robinson, Pollard, and Co., Portsea.
,, Stainsby and Lyon, Knottingley.
,, Taylor, Greenall, and Kidd, Widnes.
,, C. Tennant and Co., Glasgow.
,, Wells and Galloway, Lim., Widnes.
,, Rd. Wheen and Sons, London.
The Widnes Alkali Co., Widnes.

Circulars and Testimonials on Application.

BISULPHIDE OF CARBON
PROTOSULPHATE
RED OXIDE
OXYCHLORIDE



Sulphocyanide,

And every other Mercurial Preparation.

BISULPHITE OF LIME, TETRACHLORIDE OF CARBON.

Oxysulphuret of Antimony, Glacial Acetic Acid,

Liquor Ammoniæ,
Sulphide of Iron,
Pure Acids,
Chloride of Sulphur,
Acetone,
Chloroform,
Aldehyde,
Chlorate Baryta,
Arsenic Acids,
Fruit Essences for Confectionery & Liqueurs,
Perchloride of Iron,
Sulphite and Hyposulphite of Soda,
Phosphates of Soda and Ammonia,
Ethers,
Bromides,
Iodides,
Scale and Granular Preparations,
Sulphide of Sodium.

ALSO,

Pure Photographic Chemicals of every kind.

MANUFACTURED BY

WILLIAM BAILEY & SON,

HORSELEY FIELDS CHEMICAL WORKS,
WOLVERHAMPTON.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

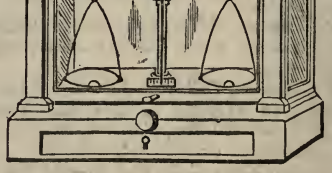
BECKER & SONS,

MANUFACTURERS OF

CHEMICAL AND GOLD ASSAY BALANCES AND OTHER

SCALES AND WEIGHTS.

ROTTERDAM.



NEW YORK.

BECKER'S STUDENT'S BALANCE, in polished mahogany glass case, sliding front, counterpoised, to carry 30 grammes in each pan and turn to ½ milligramme, nickel plated pans £2 10
Ditto, ditto, in mahogany glass case, polished black.. .. .. £2 13

Sole Agents for England, Ireland, and Wales:—

TOWNSON & MERCER.

Becker's Complete Lists forwarded by post on receipt of 1*d.* stamp or free on application.

BISULPHIDE OF CARBON,

CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,
161, 162, 163, Palmerston Buildings, London, E.C.

THE CHEMICAL NEWS.

Vol. XLII. No. 1085.

ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.

By J. H. GILBERT, Ph.D., F.R.S., V.P.C.S., F.L.S.,
President of the Section.

(Concluded from page 118.)

But one word more in reference to Dr. Siemens's results and proposed extension of his enquiries. Even supposing that by submitting growing crops to continuous light by the aid of the electric light during the night they could be brought to maturity within a period shorter than at present approximately in proportion to the increased number of hours of exposure, the estimates of the cost of illuminating the vegetation of an acre of land certainly do not seem to hold out any hope that agriculture is likely to derive benefit from such an application of science to its needs. If, however, the characters of growth and of maturation should prove to be suitable for the requirements of horticultural products of luxury and high value, it may possibly be otherwise with such productions.

The above considerations obviously suggest the question—What is the office of chlorophyll in the processes of vegetation? Is it, as has generally been assumed, confined to effecting, in some way not yet clearly understood, carbon assimilation, and, this done, its function ended? Or is it, as Pringsheim has recently suggested, chiefly of avail in protecting the subjacent cells and their contents from those rays of light which would be adverse to the secondary processes which have been distinguised as growth?

Appropriate as it would seem that I should attempt to lay before you a *résumé* of results bearing upon the points herein involved, so numerous and so varied have been the investigations which have been undertaken on the several branches of the question in recent years, that adequately to discuss them would occupy the whole time and space at my disposal. I must therefore be content thus to direct attention to the subject and pass on to other points.

It has been shown that the plant may receive abundance of nitrogen, may produce abundance of chlorophyll, and may be subject to the influence of sufficient light, and yet not assimilate a due amount of carbon. On the other hand, it has been seen that the mineral constituents may be liberally provided, and yet, in the absence of a sufficient supply of nitrogen in an available condition, the deficiency in the assimilation of carbon will be still greater. In fact, assuming all the other necessary conditions to be provided, it was seen that the amount of carbon assimilated depended on the available supply of nitrogen.

In a certain general sense it may be said that the success of the cultivator may be measured by the amount of carbon he succeeds in accumulating in his crops. And as, other conditions being provided, the amount of carbon assimilated depends on the supply of nitrogen in an available form within the reach of the plants, it is obvious that the question of the sources of the nitrogen of vegetation is one of first importance. Are they the same for all descriptions of plants? Are they to be sought entirely in the soil, or entirely in the atmosphere, or partly in the one and partly in the other?

These are the questions which Mr. Lawes and myself have discussed so frequently that it might seem some apology was due for recurring to the subject here, especially as I considered it in some of its aspects before this Section at the Sheffield Meeting last year. But the subject still remains one of first importance to agriculture, and it could not be omitted from consideration in such a review as I have undertaken to give. Moreover, there are some points connected with it still unsettled, and some still disputed.

It will be remembered that De Saussure's conclusion was that plants did not assimilate the free or uncombined nitrogen of the atmosphere, and that they derived their nitrogen from the compounds of it existing in the atmosphere, and especially in the soil. Liebig, too, concluded that plants do not assimilate nitrogen from the store of it existing in the free or uncombined state, but that ammonia was their main source, and he assumed the amount of it annually coming down in rain to be much more than we now know to be the case.

Referring to our previous papers for full details respecting most of the points in question, I will state, as briefly as I can, the main facts known—first in regard to the amount of the measurable, or as yet measured, annual deposition of combined nitrogen from the atmosphere; and, secondly, as to the amount of nitrogen annually assimilated over a given area by different crops—so that some judgment may be formed as to whether the measured atmospheric sources are sufficient for the requirements of agricultural production, or whether, or where, we must look for other supplies?

First, as to the amount of combined nitrogen coming down as ammonia and nitric acid in the measured aqueous deposits from the atmosphere.

Judging from the results of determinations made many years ago, partly by Mr. Way and partly by ourselves, in the rain, &c., collected at Rothamsted; from the results of numerous determinations made much more recently by Professor Frankland in the deposits collected at Rothamsted, and also in rain collected elsewhere; from the results obtained by Boussingault, in Alsace; from those of Marié-Davy, at the Meteorological Observatory at Montsouris, Paris; and from those of many others made in France and Germany—we concluded, some years ago, that the amount of combined nitrogen annually so coming down from the atmosphere would not exceed 8 or 10 lbs. per acre per annum in the open country in Western Europe. Subsequent records would lead to the conclusion that this estimate is more probably too high than too low. And here it may be mentioned, in passing, that numerous determinations of the nitric acid in the drainage water collected from land at Rothamsted, which had been many years unmanured, indicate that there may be a considerable annual loss by the soil in that way; indeed, probably sometimes much more than the amount estimated to be annually available from the measured aqueous deposits from the atmosphere.

It should be observed, however, that the amount of combined nitrogen, especially of ammonia, is very much greater in a given volume of the minor aqueous deposits than it is in rain; and there can be no doubt that there would be more deposited within the pores of a given area of soil than on an equal area of the non-porous even surface of a rain-gauge. How much, however, might thus be available beyond that determined in the collected and measured aqueous deposits the existing evidence does not afford the means of estimating with any certainty.

The next point to consider is—What is the amount of nitrogen annually obtained over a given area, in different crops, when they are grown without any supply of it in manure? The field experiments at Rothamsted supply important data relating to this subject.

Thus, over a period of 32 years (up to 1875 inclusive), wheat yielded an average of 20·7 lbs. of nitrogen per acre per annum, without any manure; but the annual yield has declined from an average of more than 25 lbs. over the first 8, to less than 16 lbs. over the last 12, of those 32 years; and the yield (it is true with several bad seasons) has been still less since.

Over a period of 24 years, barley yielded 18·3 lbs. of nitrogen per acre per annum, without any manure; with

a decline from 22 lbs. over the first 12 to only 14·6 lbs. over the next 12 years.

With neither wheat nor barley did a complex mineral manure at all materially increase the yield of nitrogen in the crops.

A succession of so-called "root crops"—common turnips, Swedish turnips, and sugar beet (with 3 years of barley intervening after the first eight years)—yielded, with a complex mineral manure, an averageof 26·8 lbs. of nitrogen per acre per annum over a period of 31 years. The yield declined from an average of 42 lbs. over the first 8 years to only 13·1 lbs. (in sugar beet) over the last five of the 31 years; but it has risen somewhat during the subsequent 4 years, with a change of crops to mangolds.

With the leguminous crops, beans, there was obtained, over a period of 24 years, 31·3 lbs. of nitrogen per acre per annum without any manure, and 45·5 lbs. with a complex mineral manure, including potass (but without nitrogen). Without manure the yield declined from 48·1 lbs. over the first 12 years to only 14·6 lbs. over the last 12; and with the complex mineral manure it declined from 61·5 lbs. over the first 12, to 29·5 lbs. over the last 12, years of the 24.

Again, an ordinary rotation of crops of turnips, barley, clover or beans, and wheat, gave over a period of 28 years an average of 36·8 lbs. of nitrogen per acre per annum without any manure, and of 45·2 lbs. with superphosphate of lime alone, applied once every four years, that is for the root crop. Both without manure, and with superphosphate of lime alone, there was a considerable decline in the later courses.

A very remarkable instance of nitrogen yield is the following—in which the results obtained when barley succeeds barley, that is when one gramineous crop succeeds another, are contrasted with those when a leguminous crop, clover, intervenes between the two cereal crops. Thus, after the growth of six grain crops in succession by artificial manures alone, the field so treated was divided, and, in 1873, on one half barley and on the other half clover was grown. The barley yielded 37·3 lbs. of nitrogen per acre, but the three cuttings of clover yielded 151·3 lbs. In the next year, 1874, barley succeeded on both the barley and the clover portions of the field. Where barley had previously been grown, and had yielded 37·3 lbs. of nitrogen per acre, it now yielded 39·1 lbs.; but where the clover had previously been grown, and had yielded 151·3 lbs. of nitrogen, the barley succeeding it gave 69·4 lbs., or 30·3 lbs. more after the removal of 151·3 lbs. in clover, than after the removal of only 37·3 in barley.

Nor was this curious result in any way accidental. It is quite consistent with agricultural experience that the growth and removal of a highly nitrogenous leguminous crop should leave the land in high condition for the growth of a gramineous corn crop, which characteristically requires nitrogenous manuring; and the determinations of nitrogen in numerous samples of the soil taken from the two separate portions of the field, after the removal of the barley and the clover respectively, concurred in showing considerably more nitrogen, especially in the first 9 inches of depth, in the samples from the portion where the clover had been grown than in those from the portion whence the barley had been taken. Here, then, the surface soil at any rate had been considerably enriched in nitrogen by the growth and removal of a very highly nitrogenous crop.

Lastly, clover has now been grown for twenty-seven years in succession on a small plot of garden ground which had been under ordinary garden cultivation for probably two or three centuries. In the fourth year after the commencement of the experiment the soil was found to contain, in its upper layers, about four times as much nitrogen as the farm-arable land surrounding it; and it would doubtless be correspondingly rich in other constituents. It is estimated that an amount of nitrogen has been removed in the clover crops grown corresponding to an average of not far short of two hundred pounds per acre per annum, or about ten times as much as in the cereal crops, and several times as much as in any of the other crops, growing on ordinary arable land; and, although the yield continues to be very large, there has been a marked decline over the second half of the period compared with the first. Of course calculations of the produce of a few square yards into quantities per acre can only be approximately correct. But there can at any rate be no doubt whatever that the amount of nitrogen annually removed has been very great, and very far beyond what it would be possible to attain on ordinary arable land; where, indeed, we have not succeeded in getting even a moderate growth of clover for more than a very few years in succession.

One other illustration should be given of the amounts of nitrogen removed from a given area of land by different descriptions of crop, namely, of the results obtained when plants of the gramineous, the leguminous, and other families, are growing together, as in the mixed herbage of grass-land.

It is necessary here to remind you that gramineous crops grown separately on arable land—such as wheat, barley, or oats—contain a comparatively small percentage of nitrogen, and assimilate a comparatively small amount of it over a given area. Yet nitrogenous manures have generally a very striking effect in increasing the growth of such crops. The highly nitrogenous leguminous crops (such as beans and clover), on the other hand, yield, as has been seen, very much more nitrogen over a given area, and yet they are by no means characteristically benefited by direct nitrogenous manuring; whilst, as has been shown, their growth is considerably increased, and they yield considerably more nitrogen over a given area, under the influence of purely chemical manures, and especially of potass manures. Bearing these facts in mind, the following results, obtained on the mixed herbage of grass-land, will be seen to be quite consistent.

A plot of such mixed herbage, left entirely unmanured, gave over twenty years an average of 33 pounds of nitrogen per acre per annum. Over the same period, another plot, which received annually a complex mineral manure, including potass, during the first six years, but excluding it during the last fourteen years, yielded 46·3 lbs. of nitrogen; whilst another, which received the mixed mineral manure, including potass, every year of the twenty, yielded 55·6 lbs. of nitrogen per acre per annum. Without manure there was some decline of yield in the later years; with the partial mineral manuring there was a greater decline; but with the complete mineral manuring throughout the whole period, there was even some increase in the yield of nitrogen in the later years.

Now, the herbage growing without manure comprised about fifty species, representing about twenty natural families; that growing with the limited supply of potass comprised fewer species, but a larger amount of the produce, especially in the earlier years, consisted of leguminous species, and the yield of nitrogen was greater. Lastly, the plot receiving potass every year yielded still more leguminous herbage, and, accordingly, still more nitrogen.

The most striking points brought out by the foregoing illustrations are the following:—

First. Without nitrogenous manure, the gramineous crops annually yielded, for many years in succession, much more nitrogen over a given area than is accounted for by the amount of combined nitrogen annually coming down in the measured aqueous deposits from the atmosphere.

Second. The root crops yielded more nitrogen than the cereal crops, and the leguminous crops very much more still.

Third. In all cases—whether of cereal crops, root crops, leguminous crops, or a rotation of crops—*the decline in the annual yield of nitrogen, when none was supplied, was very great.*

How are these results to be explained? Whence comes the nitrogen? and especially whence comes the much larger amount taken up by plants of the leguminous and some other families than by Gramineæ? And, lastly,

what is the significance of the great decline in the yield of nitrogen in all the crops when none is supplied in the manure?

Many explanations have been offered. It has been assumed that the combined nitrogen annually coming down from the atmosphere is very much larger than we have estimated it, and that it is sufficient for all the requirements of annual growth. It has been supposed that "broad-leaved plants" have the power of taking up nitrogen in some form from the atmosphere, in a degree, or in a manner, not possessed by the narrow-leaved Gramineæ. It has been argued that, in the last stages of the decomposition of organic matter in the soil, hydrogen is evolved, and that this nascent hydrogen combines with the free nitrogen of the atmosphere, and so forms ammonia. It has been suggested that ozone may be evolved in the oxidation of organic matter in the soil, and that, uniting with free hydrogen, nitric acid would be produced. Lastly, it has been by some concluded that plants assimilate the free nitrogen of the atmosphere, and that some descriptions are able to do this in a greater degree than others.

We have discussed these various points on more than one occasion; and we have given our reasons for concluding that none of the explanations enumerated can be taken as accounting for the facts of growth.

Confining attention here to the question of the assimilation of free nitrogen by plants, it is obvious that, if this were established, most of our difficulties would vanish. This question has been the subject of a great deal of experimental enquiry, from the time that Boussingault entered upon it, about the year 1837, nearly up to the present time. About twenty years ago it was elaborately investigated at Rothamsted. In publishing the results of that enquiry those of others relating to it were fully discussed; and although the recorded evidence is admittedly very conflicting, we then came to the conclusion, and still adhere to it, that the balance of the direct evidence on the point is decidedly against the supposition of the assimilation of free nitrogen by plants. Indeed, the strongest argument we know of in its favour is that some such explanation is wanted.

Not only is the balance of direct experimental evidence against the assumption that plants assimilate free or uncombined nitrogen, but it seems to us that the balance of existing indirect evidence is also in favour of another explanation of our difficulties.

I have asked what is the significance of the gradual decline of produce of all the different crops when continuously grown without nitrogenous manure? It cannot be that, in growing the same crop year after year on the same land, there is any residue left in the soil that is injurious to the subsequent growth of the same description of crop; for (excepting the beans) more of each description of crop has been grown year after year on the same land than the average yield of the country at large under ordinary rotation, and ordinary treatment—provided only that suitable soil conditions were supplied. Nor can the diminishing produce, and the diminishing yield of nitrogen, be accounted for on the supposition that there was a deficient supply of available mineral constituents in the soil. For it has been shown that the cereals yielded little more, and declined nearly as much as without manure, when a complex mineral manure was used, such as was proved to be adequate when available nitrogen was also supplied. So far as the root crops are concerned, the yield of nitrogen, though it declined very much, was greater at first, and on the average, than in the case of the cereals. As to the Leguminosæ, which require so much nitrogen from somewhere, it is to be observed that on ordinary arable land the yield has not been maintained under any conditions of manuring; and the decline was nearly as marked with mineral manures as without any manure. Compared with the growth of the Leguminosæ on arable land, the remarkable result with the garden clover would seem clearly to indicate that the question was one of soil, and not of atmospheric supply. And the fact that all the other crops will yield full agricultural results even on ordinary arable land, when proper manures are applied, is surely very strong evidence that it is with them, too, a question of soil, and not of atmospheric supply.

But we have other evidence leading to the same conclusion. Unfortunately we have not reliable samples of the soil of the different experimental fields taken at the commencement of each series of experiments, and subsequently at stated intervals. We have nevertheless, in some cases, evidence sufficient to show whether or not the nitrogen of the soil has suffered diminution by the continuous growth of the crop without nitrogenous manure.

Thus, we have determined the nitrogen in the soil of the continuously unmanured wheat plot at several successive periods, and the results prove that a gradual reduction in the nitrogen of the soil is going on; and, so far as we are able to form a judgment on the point, the diminution is approximately equal to the nitrogen taken out in crops, and the amount estimated to be received in the annual rainfall is approximately balanced by the amount lost by the land as nitrates in the drainage water.

In the case of the continuous root-crop soil, on which the decline in the yield of nitrogen in the crop was so marked, the percentage of nitrogen, after the experiment had been continued for twenty-seven years, was found to be lower where no nitrogen had been applied than in any other arable land on the farm which has been examined.

In the case of the experiments on the mixed herbage of grass land, the soil of the plot which, under the influence of a mixed mineral manure, including potass, had yielded such a large amount of leguminous herbage and such a large amount of nitrogen, showed, after twenty years, a considerably lower percentage of nitrogen than that of any other plot in the series.

Lastly, determinations of nitrogen in the garden soil which has yielded so much nitrogen in clover, made in samples collected in the fourth and the twenty-sixth years of the twenty-seven of the experiments, show a very large diminution in the percentage of nitrogen. The diminution, to the depth of 9 inches only, represents approximately three-fourths as much as the amount estimated to be taken out in the clover during the intervening period; and the indication is, that there has been a considerable reduction in the lower depths also. It is to be supposed, however, that there would be loss in other ways than by the crop alone.

I would ask, Have we not in these facts—that full amounts of the different crops can be grown, provided proper soil conditions are supplied; that without nitrogenous manure the yield of nitrogen in the crop rapidly declines; and that, coincidently with this, there is a decline in the percentage of nitrogen in the soil—have we not in these facts cumulative evidence pointing to the soil, rather than to the atmosphere, as the source of the nitrogen of our crops?

In reference to this point, I may mention that the ordinary arable soil at Rothamsted may be estimated to contain about 3000 lbs. of nitrogen per acre in the first 9 inches of depth, about 1700 lbs. in the second 9 inches, and about 1500 lbs. in the third 9 inches,—or a total of about 6200 lbs. per acre to the depth of 27 inches.

In this connection it is of interest to state that a sample of Oxford clay, obtained in the Sub-Wealden exploration boring, at a depth of between 500 and 600 feet (and which was kindly given to me by the President of the Association, Professor Ramsay, some years ago), showed, on analysis at Rothamsted, approximately the same percentage of nitrogen as the subsoil at Rothamsted taken to the depth of about 4 feet only.

Lastly, in a letter received from Boussingault some years ago, referring to the sources whence the nitrogen of vegetation is derived, he says:—

"From the atmosphere, because it furnishes ammonia in the form of carbonate, nitrates, or nitrites, and various kinds of dust. Theodore de Saussure was the first to demonstrate the presence of ammonia in the air, and con-

sequently in meteoric waters. Liebig exaggerated the influence of this ammonia on vegetation, since he went so far as to deny the utility of the nitrogen which forms a part of farm-yard manure. This influence is nevertheless real, and comprised within limits which have quite recently been indicated in the remarkable investigations of M. Schlösing.

"From the soil, which, besides furnishing the crops with mineral alkaline substances, provides them with nitrogen, by ammonia, and by nitrates, which are formed in the soil at the expense of the nitrogenous matters contained in diluvium, which is the basis of vegetable earth; compounds in which nitrogen exists in stable combination, only becoming fertilising by the effect of time. If we take into account their immensity, the deposits of the last geological periods must be considered as an inexhaustible reserve of fertilising agents. Forests, prairies, and some vineyards have really no other manures than what are furnished by the atmosphere and by the soil. Since the basis of all cultivated land contains materials capable of giving rise to nitrogenous combinations, and to mineral substances, assimilable by plants, it is not necessary to suppose that in a system of cultivation the excess of nitrogen found in the crops is derived from the free nitrogen of the atmosphere. As for the absorption of the gaseous nitrogen of the air by vegetable earth, I am not acquainted with a single irreproachable observation that establishes it; not only does the earth not absorb gaseous nitrogen, but it gives it off, as you have observed in conjunction with Mr. Lawes, as Reiset has shown in the case of dung, as M. Schlösing and I have proved in our researches on nitrification.

"If there is one fact perfectly demonstrated in physiology, it is this of the non-assimilation of free nitrogen by plants; and I may add by plants of an inferior order, such as mycoderms and mushrooms."—(Translation.)

If, then, our soils are subject to a continual loss of nitrogen by drainage, probably in many cases more than they receive of combined nitrogen from the atmosphere—if the nitrogen of our crops is derived mainly from the soil, and not from the atmosphere—and if, when due return is not made from without, we are drawing upon what may be termed the store of nitrogen of the soil itself—is there not, in the case of many soils at any rate, as much danger of the exhaustion of their available nitrogen as there has been supposed to be of the exhaustion of their available mineral constituents?

I had hoped to say something more about soils, to advance our knowledge respecting which an immense amount of investigation has been devoted of late years, but in regard to which we have yet very much more to learn. I must, however, now turn to other matters.

I have thus far directed attention to some points of importance in connection with the sources of the constituents of our crops, and I must now briefly refer to some in connection with the composition, and to some relating to the uses, of the crops themselves.

As to composition, I must confine myself to indicating something of what is known of the condition of the nitrogen in our various crops; though I had intended to say something respecting the carbo-hydrates, and especially respecting the various members of the cellulose group.

As to the nitrogen—in our first experiments on the feeding of animals, made in 1847, 1848, and 1849, the results of which were published in the last-mentioned year—we found that, in the case of succulent roots used as food, not only were they not of value as food in proportion to their richness in nitrogen, but when the percentage of it was higher than a certain normal amount, indicating relative succulence and immaturity, they were positively injurious to the animals. So marked was the variation of result, according to the condition of maturity or otherwise of the foods employed, that, when reviewing the results of the experiments which had up to that time been conducted, in a paper read before this Section of the British Association at the Belfast Meeting in 1852 (and which was published in full in the annual volume*), we stated that the mode of estimating the amount of proteine compounds by multiplying the percentage of nitrogen by 6·3 was far from accurate, especially when applied to succulent vegetable foods, and that the individual compounds ought to be determined. The Rothamsted Laboratory staff was, however, much smaller then than it is now, and, with the pressure of many other subjects upon us, it was at that time quite impossible to follow up the enquiry in that direction.

It is, indeed, only within the last ten years or so that the question has been taken up at all systematically; but we are already indebted to E. Schulze, A. Urick, Church, Sachsse, Maercker, Kellner, Vines, Emmerling, and others, for important results relating to it.

Our knowledge in regard to the subject is, however, still very imperfect. But it is in progress of investigation from two distinctly different points of view—from that of the vegetable physiologist, and that of the agricultural chemist. The vegetable physiologist seeks to trace the changes that occur in the germination of the seed, and during the subsequent life-history of the plant, to the production of seed again. The agricultural chemist takes the various vegetable products in the condition in which they are used on the farm, or sold from it. And as a very large proportion of what is grown—such as grass, hay, roots, tubers, and various green crops—are not matured productions, it comes to be a matter of great importance to consider whether or not any large proportion of the nitrogenous contents of such products is in such condition as not to be of avail to the animals which consume them in their food?

We cannot say that the whole of the nitrogen in the seeds with which we have to deal exists as albuminoids. But we may safely assume that the nearer they approach to perfect ripeness, the less of non-albuminoid nitrogenous matters will they contain; and, in the case of the cereal grains at any rate, it is probable that if really perfectly ripe they will contain very nearly the whole of their nitrogen as albuminoids. With regard to some leguminous and other seeds, which contain peculiar nitrogenous bodies, the range may, however, be wider.

But whatever the condition of the nitrogenous bodies in the seeds we grow or sow, with germination begins a material change. Albuminoids are transformed into peptones, or peptone-like bodies, or degraded into various amido- or other compounds. Such change into more soluble and more diffusible bodies is, it is to be supposed, essential to their free migration and to their subserviency to the purposes of growth. In the case of the germination, especially of some leguminous seeds, asparagine has been found to be a very prominent product of such degradation of the albuminoids; but it would seem that this disappears as the green parts are developed. But now the plant begins to receive supplies of nitrogen from the soil, as nitrates or ammonia, and it would seem that amides constitute a considerable proportion of the produced nitrogenous bodies, apparently as an intermediate stage in the formation of albuminoids. At any rate such bodies are found to exist largely in the immature plant, whilst the amount of them diminishes as the plant or its various parts approach to maturity.

But not only have we thus, in unripened vegetable productions, a greater or less, and sometimes a very large, proportion of the nitrogenous bodies formed within the plant existing as amido-compounds, but we may have a large amount existing in the juices as nitric acid, and some as ammonia, &c. Thus, E. Schulze determined the nitric acid in various "roots," and he found that, in some mangels, more than one-third of the total nitrogen existed in that form, and about one-tenth as much as ammonia. In a considerable series at Rothamsted we have found an ex-

* "On the Composition of Foods in relation to Respiration and the Feeding of Animals.

tremely variable proportion existing as nitric acid, according to the size, succulence, or degree of maturity, of the roots; the amount being, as a rule, the least with the ripest and less highly nitrogenous roots, and the most with the most succulent, unripe, and highly nitrogenous ones. In some cases it reached as much as from 20 to nearly 30 per cent of the total nitrogen. In many other immature vegetable products nitric acid and ammonia have been found, but, so far as I remember, in none in anything like so large a proportion as in the so-called "root-crops," especially mangels. In many, however, the quantity appears to be immaterial; and it is remarkable that whilst there is so much in the "roots," little or none is found in potatoes.

No wonder that, in the experiments already referred to, we found the feeding result to be the worse the more succulent and immature the roots, and the higher their percentage of nitrogen, accordingly.

But it is to the difference in amount of the albuminoid bodies themselves, in different descriptions of vegetable produce, that I wish specially to direct attention, making, however, some reference to what is known of the proportion of the nitrogen existing as amido-compounds.

In some mangels E. Schulze found only from about 20 to 22 per cent of their total nitrogen to exist as insoluble and soluble albumin. But he found in one case 32·5, and in the other 40·8, per cent of the total nitrogen as amides. In a large series of determinations at Rothamsted, by Church's method, we found a variation of from under 20 to over 40 per cent of the total nitrogen of mangels to exist as albuminoids; or, in other words, from nearly 60 to over 80 per cent of it in the non-albuminoid condition.

In potatoes Schulze found from under 50 to 65 per cent of the total nitrogen as soluble and insoluble albumin, and from 27·7 to 49·1 per cent as neutral and acid amides. In a series of potatoes grown at Rothamsted, under very various conditions as to manuring, and in two different seasons, we found the nitrogen as albuminoids to range from little over 50 to more than 71 per cent of the total nitrogen, leaving, of course, from less than 30 to nearly 50 per cent to be accounted for in other ways.

Kellner determined the amount of nitrogen as albuminoids, and as amido-compounds, in a considerable series of green foods, both leguminous and gramineous, cut at different stages of their growth. The proportion of the total nitrogen not as albuminoids was, upon the whole, greater in the Leguminosæ than in the Gramineæ. In both, however, the proportion as albuminoids increased as the plants approached to maturity. The proportion as albuminoids was in all these products very much larger than in roots, and generally larger than in potatoes. In the case of first-crop meadow hay, we found in the separated gramineous herbage 76·4, in the leguminous herbage 82, and in the miscellaneous herbage 80·3 per cent of the nitrogen as albuminoids; and in the second crop 86·2 per cent in the gramineous, 88·3 per cent in the leguminous, and 88·1 per cent in the miscellaneous herbage. How far the higher proportion of the nitrogen as albuminoids in the second crops is to be taken as any indication of the characteristics of the autumn growth, or how far it is to be attributed to the accidental condition of the weather, may be a question.

These illustrations are sufficient to give some idea of the range and proportion of the nitrogen in different feeding crops which does not exist as albuminoids; and they are sufficient to show that a very large proportion of the non-albuminoid matter exists as various amido-compounds. The question arises, therefore, whether these bodies contribute in any way to the nutrition of the animals which feed upon them? We have but little experimental evidence on this point. As green herbage is the natural food of many descriptions of animal, we might suppose that characteristic constituents of it would not be without some value as food; but the cultivated root crops are much more artificial productions, and it is in them that we find such a very large proportion of non-albuminoid nitrogen. With respect to some of the amido-compounds, at any rate, direct experiments seem to show that they are digested in the animal body, and increase the elimination of urea. Weiske and Schrodt found that rabbits receiving, as their only nitrogenous food, either asparagine or gelatin, wasted and died; but a rabbit receiving both asparagine and gelatin increased in weight and survived to the end of the experiment, which lasted seventy-two days. From the results of other experiments made with sheep, they concluded that both asparagine and gelatin protect the albuminoids of the body from oxidation.

These considerations lead me, in conclusion, to refer briefly, and I promise it shall be as briefly as is consistent with clearness, to the two very much disputed questions of *the origin of muscular power*, and *the sources of the fat of the animal body*. These subjects Mr. Lawes and myself have frequently discussed elsewhere; but as the controversy has assumed a new phase quite recently, it seems desirable and appropriate that I should recur to it on the present occasion.

With regard to the question of the sources in the food of the fat of the animal body, Liebig originally maintained that although fat might be formed from the nitrogenous compounds within the body, the main source of it in the herbivora was the carbo-hydrates. In his later writings, he sharply criticised the experiments and arguments of those who have maintained the formation of fat chiefly from the proteine compounds; but he at the same time seems to attach more importance to that source than he formerly did. He gives it as his opinion that the question cannot be settled by experiments with herbivora. He adds that what we know with certainty is that, with these animals, albuminates and carbohydrates work together to produce fat; but whether the non-nitrogenous product, fat, has its origin in the albumin or in the carbohydrate, he considers it not easy to determine.

At the time when we commenced our experiments on the feeding of animals in 1847, the question whether the fat of the animals fed for human food was mainly derived from albuminoids or from carbohydrates had been scarcely raised, or at least it was not prominent. The question then was rather—whether the herbivora received their fat ready formed in their food, or whether it was produced within the body—the latter view being that which Liebig had so forcibly urged, at the same time maintaining that at any rate its chief source was the carbohydrates. Accordingly, our experiments were not specially arranged to determine whether or not the whole of the fat produced could or could not be derived from the albuminoids.

For each description of animal, oxen, sheep, and pigs, such foods as had been established by common experience to be appropriate were selected. The general plan of the experiments was, to give to one set a fixed amount of a recognised good food, containing known quantities of nitrogen, fatty matter, &c., to another set the same amount of another food, of different characters in these respects; to other sets also fixed amounts of other foods in the same way: and then there was given to the whole series the same complementary food *ad libitum*. Or, to one set was supplied a uniform food rich in nitrogen, and to others uniform foods poorer in nitrogen, and so on, in each case *ad libitum*.

It will be seen that, in this way, a great variety of dietaries was arranged, and it will be observed that in each case the animals themselves fixed their consumption according to the requirements of the system.

As already indicated, the individual nitrogenous and non-nitrogenous compounds of the foods were not determined. As a rule, the constituents determined were—the total dry matter, the ash, the fatty matter, and the nitrogen; from which last the amount of nitrogenous compound it might represent was calculated by the usual factor. But, as already said, the results so obtained were only used with considerable reservation, especially in the case of all immature vegetable produce. Nor was the

crude fibre determined; but, as in the case of the estimated nitrogenous substance, when interpreting the results, it was always considered whether or not the food contained much or little of probably indigestible woody matter.

The animals being periodically weighed, we were thus able to calculate the amounts of the so-estimated nitrogencus substance, and of the total non-nitrogenous substance, including and excluding fat, consumed—*for a given live-weight within a given time*, and *to produce a given amount of increase in live-weight*.

Experiments were made with a large number of sheep and a large number of pigs. And, even without making allowance for the different condition of the nitrogenous or of the non-nitrogenous constituents, in comparable foods, the results so uniformly indicated that, both the amount consumed by a given live-weight of animal within a given time, and that required to produce a given amount of increase, were determined much more by the amount of the non-nitrogenous than by that of the nitrogenous constituents which the food supplied. And when allowance was made for the different condition of the nitrogenous constituents, and for the greater or less amount of the non-nitrogenous ones which would probably be indigestible and effete, the indications were still more remarkable and conclusive.

In very many cases the animals were slaughtered, and carefully examined as to whether the tendency of development had been more that of growth in frame and flesh, or in fatness. Here, again, the evidence was clear, that the tendency to growth in frame and flesh was favoured by a high proportion of nitrogen in the food, and that to the production of fat by a high proportion of digestible non-nitrogenous constituents.

In a few cases the actual amount of fat in the animals in the lean, and in the fat condition, was determined; and the results admitted of no doubt whatever that a very large proportion of the stored-up fat could not have been derived from the fatty matter of the food, and must have been produced within the body.

So decisive and consistent were the very numerous and very varied results in regard to these points, that we had no hesitation in concluding—not only that much of the fat stored up was produced within the body, but that the source of much, at any rate, of the produced fat must have been the non-nitrogenous constituents of the food—in other words, the *carbohydrates*.

As already stated, however, as the question whether the source of the produced fat was the proteine compounds or the carbohydrates was not then prominent, we had not so arranged the experiments as to obtain the largest possible increase in fat with the smallest possible supply of nitrogenous compounds in the food, nor did we then even calculate whether or not there was sufficient nitrogenous matter consumed to be the source of the whole of the fat produced.

This question, indeed, excited very little interest, until, at a meeting of the Congress of Agricultural Chemists held at Munich, in 1865 (at which I happened to be present), Professor Voit, from the results of experiments made in Pettenkofer's respiration apparatus with dogs fed on flesh, announced his conclusion that fat must have been produced from the nitrogenous substance, and that this was probably the chief, if not the only, source of the fat, even of herbivora—an opinion which he subsequently urged much more positively.

In the discussion which followed the reading of Prof. Voit's paper, Baron Liebig forcibly called in question his conclusions; maintaining not only that it was inadmissible to form conclusions on such a point in regard to herbivora, from the results of experiments made with carnivora, but also that direct quantitative results obtained with herbivorous animals had afforded apparently conclusive evidence in favour of the opposite view.

Voit's paper excited considerable controversy, in which Mr. Lawes and myself joined. We maintained that experiments to determine such a question should be made not with carnivora or omnivora fed on flesh, but with herbivora fed on their appropriate fattening food, and on such herbivora as common experience showed to be pre-eminently fat-producers. We pointed out* that the pig comprised, for a given live-weight, a comparatively small proportion of alimentary organs and contents; that, compared with that of the ruminants, his food was of a high character, yielding, for a given weight of it, much more total increase, much more fat, and much less necessarily effete matter; that, in proportion to his weight, he consumes a larger amount of food, and yields a larger amount, both of total increase and of fat, within a given time; and, lastly, that he contains a larger proportion of fat, both in a given live-weight and in his increase whilst fattening.

It is obvious that, with these characteristics, there is much less probable range of error in calculating the amount and the composition of the increase in live-weight in relation to the amount and composition of the food consumed, than in the case of the ruminants; and that, therefore, the pig is very much more appropriate for the purpose of experiments to determine the sources in its food of the fat it produces.

Accordingly, we calculated a number of our early experiments made with pigs, to determine whether or not the nitrogenous substance they consumed was sufficient for the formation of the fat they produced. For simplicity of illustration, and to give every possible advantage to the view that nitrogenous substance might have been the source of the produced fat, we assumed the whole of the crude fat of the food to have been stored up in the animal—thus estimating a minimum amount to be produced. Then, again, we supposed the whole of the nitrogenous substance of the food to be perfectly digested, and to become available for the purposes of the system. Lastly, after deducting the amount of nitrogenous substance estimated to be stored up as such, the whole of the remainder was reckoned to be so broken up that no other carbon compounds than fat and urea would be produced.

The result was, that, even adopting these inadmissible assumptions, in all the cases in which, according to common experience, the food was admittedly the most appropriate for the fattening of the animal, the calculation showed that a large amount of fat had been produced which could not have been derived from the nitrogenous substance of the food, and must therefore have had its source in the carbohydrates. Such a result is, moreover, entirely accordant with experience in practical feeding.

Reviewing the whole subject in great detail in 1869, Professor Voit refers to these results and calculations. He confesses that he has not been able to get a general view of the experiments from the mass of figures recorded, and from his comments he shows that he has on some points misunderstood them. He admits, however, that, as the figures stand, it would appear that fat had, in some instances, been derived from the carbohydrates. Still, he says, he cannot allow himself to consider that a transformation of carbohydrates into fat has thus been proved.

Professor Emil von Wolff, again, in his *Landwirthschaftliche Fütterungslehre*, referring to the same experiments, admits that they are almost incomprehensible unless we assume the direct concurrence of the carbohydrates in the formation of fat. He nevertheless seems to consider that evidence of the kind in question is inconclusive; and he suggests that experiments with pigs should be made in a respiration apparatus to determine the point.

Mr. Lawes and myself entertained, however, the utmost confidence that the question was of easy settlement without any such apparatus, provided only suitable animals and suitable foods were selected. I accordingly gave a paper on the subject in the *Section für Landwirthschaft und Agricultur Chemie*, at the *Naturforscher Versammlung*,

* "On the Sources of the Fat of the Animal Body," *Philosophical Magazine*, December, 1866.

held at Hamburg, in 1876.* The points which I particularly insisted upon were—that the pig should be the subject of experiment; that he should be allowed to take as much as he would eat of his most appropriate fattening food, so that his increase, and the fat he produced, should bear as large a proportion as possible to his weight, to the total food, and to the total nitrogenous substance consumed. Finally, it was maintained that, if these conditions were observed, and the constituents of the food determined, and those of the increase of the animal estimated according to recognised methods, the results could not fail to be perfectly conclusive, without the intervention, either of a respiration apparatus, or of the analysis of the solid and liquid matters voided.

Results so obtained were adduced in proof of the correctness of the conclusions arrived at. We at the same time admitted, that although, for reasons indicated, we had always assumed that fat was formed from the carbohydrates in the case of ruminants as well as of pigs, yet, as in our experiments with those animals we had supplied too large amounts of ready-formed fat, or of nitrogenous matter, or of both, it could not be shown so conclusively by the same mode of calculation in their case as in that of pigs.

In the discussion which followed, Professor Henneberg agreed that it seemed probable that fat could be formed from the carbohydrates in the case of pigs. In the case of experiments with other animals, however, the amount of fat produced was too nearly balanced by the amount of fat and albuminous matters available, to afford conclusive evidence on the point.

Quite recently, Professor Emil von Wolff (*Landwirthschaftliche Jahrbücher*, band viii., 1879, Supplement) has applied the same mode of calculation to results obtained by himself with pigs some years ago. He concluded that the whole of the body fat could not have been formed without the direct co-operation of the carbohydrates of the food. But what is of greater interest still is that he also calculated, in the same way, the results of some then quite recent experiments of Henneberg, Kern, and Wattenberg, with sheep. He thus found that, even including the whole of the estimated amides with the albumin, there must have been a considerable production of fat from the carbohydrates; and, excluding the amides, the amount reckoned to be derived from the carbohydrates was of course much greater.

I will only add, on this point, that, on re-calculating some of our early results with sheep, which did not afford sufficient conclusive evidence when the whole of the nitrogen of the food was reckoned as albumin, show a very considerable formation of fat from the carbohydrates, if deduction be made for the probable amount of non-albuminoid nitrogenous matter of the food.

We have now, then, the two agricultural chemists of perhaps the highest authority, both as experimenters and writers on this subject on the continent, giving in their adhesion to the view, that the fat of the herbivora, which we feed for human food, may be, and probably is, largely produced from the carbohydrates. I dare say, however, that some physiologists will not change their view until Voit gives them sanction by changing his, which, so far as I know, he has not yet done.

The question which has been currently entitled that of "The Origin of Muscular Power," or "The Sources of Muscular Power," has also been the subject of much investigation, and of much conflict of opinion, since the first publication of Liebig's views respecting it in 1842.

As I have already pointed out, he then maintained that the amount of muscular tissue transformed, the amount of nitrogenous substance oxidated, was the measure of the force generated in the body. He accordingly concluded that the requirement for the nitrogenous constituents of food would be increased in proportion to the increase of the source expended. In his more recent writings on the subject, he freely criticises those who take an opposite view. He nevertheless grants that the secretion of urea is not a measure of the force exerted; but, on the other hand, he does not commit himself to the admission that the oxidation of the carbohydrates is a source of muscular power.

The results of our own early and very numerous feeding experiments were, as has been said, extremely accordant in showing that, provided the nitrogenous constituents in the food were not below a certain rather limited amount, it was the quantity of the digestible and available non-nitrogenous constituents, and not that of nitrogenous substance, that determined—both *the amount consumed by a given live-weight within a given time*, and *the amount of increase in live-weight produced*. They also showed that one animal, or one set of animals, might consume two or three times as much nitrogenous substance in proportion to a given live-weight within a given time as others in precisely comparable conditions as to rest or exercise. It was further proved that they did not store up nitrogenous substance at all in proportion to the greater or less amount of it supplied in the food, but that the excess reappeared in the liquid and solid matters voided.

So striking were these results that we were led to turn our attention to human dietaries, and also to a consideration of the management of the animal body undergoing somewhat excessive labour, as, for instance, the hunter, the racer, the cab-horse, and the foxhound, and also pugilists and runners. Stated in a very words, the conclusion at which we arrived from these enquiries (which were summarised in our paper given at Belfast in 1852) was—that, unless the system were overtaxed, the demand induced by an increased exercise of force was more characterised by an increased requirement for the more specially respiratory, than for the nitrogenous, constituents of food.

Soon afterwards, in 1854, we found by direct experiments with two animals in exactly equal conditions as to exercise, both being in fact at rest, that the amount of urea passed by one feeding on highly nitrogenous food was more than twice as great as that fed on a food comparatively poor in nitrogen.

It was clear, therefore, that the rule which had been laid down by Liebig, and which has been assumed to be correct by so many writers, even up to the present time, did not hold good—namely, that "The sum of the mechanical effects produced in two individuals, in the same temperature, is proportional to the amount of nitrogen in their urine; whether the mechanical force has been employed in voluntary or involuntary motions, whether it has been consumed by the limbs or by the heart and other viscera"—unless, indeed, as has been assumed by some experimenters, there is, with increased nitrogen in the food, an increased amount of mechanical force employed in the "involuntary motions" sufficient to account for the increased amount of urea voided.

The question remained in this condition until 1860, when Bischoff and Voit published the results of a long series of experiments made with a dog. They found that, even when the animal was kept at rest, the amount of urea voided varied closely in proportion to the variation in the amount of nitrogenous substance given in the food—a fact which they explained on the assumption that there must have been a corresponding increase in the force exercised in the conduct of the actions proceeding within the body itself in connection with the disposal of the increased amount of nitrogenous substance consumed. Subsequently, however, they found that the amount of urea passed by the animal was, with equal conditions as to food, &c., no greater when he was subjected to labour than when at rest; whilst, on the other hand, the carbonic acid evolved was much increased by such exercise. They accordingly somewhat modified their views.

In 1866 appeared a paper by Professors Fick and Wislicenus, giving the results obtained in a mountain ascent. They found that practically the amount of urea voided

* The substance of that communication is given in the *Journa o natomy and Physiology* vol. xi., part iv.

was scarcely increased by the labour thus undertaken. Professor Frankland gave an account of these experiments in a lecture at the Royal Institution in the same year; and he subsequently followed up the subject by an investigation of the heat developed in the combustion of various articles of food, applying the results in illustration of the phenomena of the exercise of force.

Lastly, Kellner has made some very interesting experiments with a horse at Hohenheim, the results of which were published last year. In one series, the experiment was divided into five periods, the same food being given throughout; but the animal accomplished different distances, and drew different weights, the draught being measured by a horse dynamometer. The changes in live-weight, the amount of water drank, the temperature, the amount of matters voided, and their contents in nitrogen, were also determined.

The result was, that with only moderate labour there was no marked increase in the nitrogen eliminated in the urine; but that with excessive labour the animal lost weight and eliminated more nitrogen. Kellner concluded, accordingly, that, under certain circumstances, muscular action can increase the transformation of albumin in the organism in a direct way; but that, nevertheless, in the first line is the oxidation of the non-nitrogenous matters —carbohydrates and fat, next comes in requisition the circulation albumin, and finally the organ albumin is attacked.

In reference to these conclusions from the most recent experiments relating to the subject, we may wind up this brief historical sketch of the changes of view respecting it, with the following quotation from our own paper published in 1866*:—" . . . . all the evidence at command tended to show that by an increased exercise of muscular power there was, with increased requirement for respirable material, probably no increased production and voidance of urea, unless, owing to excess of nitrogenous matter in the food, or a deficiency of available non-nitrogenous substance, or diseased action, the nitrogenous constituents of the fluids or solids of the body were drawn upon in an abnormal degree for the supply of respirable material."

In conclusion, although I fully agree with Voit, Zuntz, Wolff, and others, that there still remains much for both Chemistry and Physiology to settle in connection with these two questions of "The Sources of the Fat of the Animal Body," and "The Origin of Muscular Power," yet I think we may congratulate ourselves on the re-establishment of the true faith in regard to them, so far at least as the most important practical points are concerned.

THE CONDITIONS NECESSARY FOR THE EXISTENCE OF MATTER IN THE LIQUID STATE.
EXISTENCE OF ICE AT HIGH TEMPERATURES.

By THOMAS CARNELLEY.

Numerous experiments which I have made during the last few weeks on the boiling-points of substances under low pressures, the details of which will shortly be published, have led to the following conclusions in reference to the conditions necessary for the existence of any substance in the liquid state. These are two in number, viz.:—

1. In order to convert a gas into a liquid the *temperature* must be *below* a certain point (termed by Andrews the *critical temperature* of the substance), otherwise no amount of pressure is capable of liquefying the gas.
2. In order to convert a solid into a liquid the *pressure* must be *above* a certain point, which I propose to call the *critical pressure* of the substance, otherwise no amount of heat will melt the substance.

If the second of the above conditions be true, it follows that if the necessary temperature be attained the liquefaction of the substance depends solely on the superincumbent pressure; so that if by any means we can keep the pressure on the substance below its critical pressure no amount of heat will liquefy it, for in this case the solid substance passes directly into the state of gas, or, in other words, it sublimes without previous melting.

Having come to this conclusion it was easily foreseen that if these ideas were correct it would be possible to have *solid ice at temperatures far above the ordinary melting-point.* After several unsuccessful attempts I was so fortunate as to attain the most perfect success, and have obtained solid ice at temperatures so high that it was impossible to touch it without burning one's self. This result has been obtained many times and with the greatest ease, and not only so, but on one occasion a small quantity of water was frozen in a glass vessel which was so hot that it could not be touched by the hand without burning it. I have had ice for a considerable length of time at temperatures far above the ordinary boiling-point, and even then it only sublimed away without any previous melting. These results were obtained by *maintaining* the superincumbent pressure below 4·6 m.m. of mercury, *i.e.*, the tension of aqueous vapour at the freezing-point of water. Other substances also exhibit these same phenomena, the most notable of which is mercuric chloride, for which latter the pressure need only be reduced to about 420 m.m. On letting in the pressure the substance at once liquefies.

For the success of these experiments in the case of water one or two details of manipulation are necessary, but these will be subsequently described.

Firth College, Sheffield, September 6, 1880.

* "Food in its Relations to Various Exigencies of the Animal Body," *Phil. Mag.*, July, 1866.

ON THE CONDITION OF CARBON IN STEEL, AND THE EFFECT OF "HARDENING" UPON IT.

By THOMAS W. HOGG.

In connection with the observations published by Mr. Parker in the Chemical News, vol. xlii., p. 88, I beg to submit the following results which were obtained some time ago while trying a number of hardening experiments for Messrs. John Spencer and Sons. I may here remark that their publication was delayed with the view of making them more complete. I therefore, in consideration of Mr. Parker's prior publication, submit them as a more complete addition to the same. (See Table next page.)

The first three are samples of a peculiar kind of steel, and were selected for these experiments on account of the large amount of graphite present in them. No. 4 is a sample of B. Vaughan's steel, and No. 6 a sample of file steel.

All these samples were hardened in cold water with the exception of A. After hardening, the first three samples were kept in an annealing furnace three or four days, the other samples being softened by merely allowing them to cool in ashes after heating them to the required temperature.

In connection with the above analyses the following were the methods used:—

Colour test.—These were all made by means of a carefully-prepared standard of hammered crucible steel, which contained the merest trace of graphite. In the case of the hardened samples which could not be drilled, these were found to be easily broken into splinters on prolonged hammering with a hard hammer. The splinters obtained from the centre of the material, and weighing approxi-

HARDENING EXPERIMENTS.

No. 1 Sample—

	Before Hardening.	Hardened.	Annealed or Softened.
Combined carbon (colour test)	0·89	0·58	0·98
Graphitic carbon	0·29	traces	0·20
Total carbon (cl. test + graphite)	1·18	0·58	1·18
Total carbon (by combustion)	1·18	1·09	1·20

No. 2 Sample—

Combined carbon	0·80	0·66	0·79
Graphitic carbon	0·34	0·07	0·44
Total carbon (cl. test + graphite)	1·14	0·73	1·23
Total carbon (by combustion)	1·21	1·10	1·19

No. 3 Sample—

Combined carbon	0·93	0·60	0·80
Graphitic carbon	0·11	traces	0·25
Total carbon (cl. test + graphite)	1·04	0·60	1·05
Total carbon (by combustion)	1·00	0·97	1·00

No. 4 Sample—

Combined carbon	0·38	0·22	0·38
Graphitic carbon	0·04	none	traces
Total carbon (cl. test + graphite)	0·42	0·22	0·38
Total carbon (by combustion)	0·39	0·34	0·38

No. 5 Sample—

Combined carbon	0·45	0·21	0·39
Graphitic carbon	0·04	none	0·07
Total carbon (cl. test + graphite)	0·49	0·21	0·46
Total carbon (by combustion)	0·47	0·50	0·48

No. 6 Sample—

Combined carbon	1·05	0·52	0·94
Graphitic carbon	traces	traces	0·06
Total carbon (cl. test + graphite)	1·05	0·52	1·00
Total carbon (by combustion)	0·99	1·02	0·98

Sample marked A.—

	Before Hardening.	Hardened in Water.	Hardened in Oil.
Combined carbon	0·50	0·23	0·33
Graphitic carbon	0·04	traces	0·04
Total carbon (cl. test + graphite)	0·54	0·23	0·37
Total carbon (by combustion)	0·56	0·54	0·53

mately 0·1 grm., were specially retained for colour test; the weight of standard being made exactly equal to that of the splinter, and the comparisons being made by a very simple method to be described hereafter.

Combustion.—The samples were treated with neutral cupric chloride, the carbon separated from the precipitated copper by means of cupric chloride, and hydrochloric acid, filtered on an asbestos filter, washed with hydrochloric acid until the washings were colourless, then with hot water, then dried, and mixed with black oxide copper, and burnt in a current of pure oxygen as usual.

Graphite.—Before making these determinations, I tried the following preliminary experiments, in order to see whether the strength of the acid used and its temperature had any effect upon the amount found:—

A. The sample was dissolved in hot strong hydrochloric acid (1·16 sp. gr.). Graphite = 0·24 per cent.
B. The sample was dissolved in hot dilute (the above *plus* an equal bulk of H_2O.) Graphite = 0·20 p.c.
C. The sample was dissolved in cold dilute (as in B). Graphite = 0·20 per cent.

I concluded from these and a great many other results that the amount found by using hydrochloric acid of varying strengths within ordinary limits would not differ (practically) if the air was carefully excluded and the solution filtered immediately after the last particle of steel had dissolved, as it is improbable that any graphite would be decomposed in the presence of the escaping nascent hydrogen. The graphite being here in a very minute state of division, hydrochloric acid in the presence of air and with the aid of heat attacks it very rapidly. I therefore (with the above precautions) used the method B, as the time required for perfect solution was very much less than C. The carbon was separated on an asbestos filter, and burnt in oxygen as usual, the accuracy of the apparatus being verified by blank experiments and burning very small quantities of sugar. This was necessary on account of the very small amounts of graphite present in some cases. Probably the process recently elaborated by Dr. Dupré for this purpose would here be of great advantage, but for want of time I was obliged to forego it.

Apart from the considerations to be applied to the various phenomena connected with hardening, the above results, together with Mr. Parker's, point out the probable cause of the discrepancies which frequently occur amongst chemists, for it is evident that two samples of steel may yield identical results by colour test and yet differ very considerably by combustion, or *vice versa*. In fact, by hardening the sample at different temperatures, or cooling in different fluids, it seems possible *to cause the sample to yield any required colour test within certain limits*. For instance, it would be possible to cause No. 6 sample above by a little manipulation to yield colour tests ranging from 0·52 to 1·02.

On examining the results detailed above it will be seen that the difference observed is much greater than those described by Mr. Parker. The reason for this is to be found in the fact that his samples were hardened under conditions not favourable to the production of the maximum hardness capable of being produced by cold water.

With regard to the peculiar reactions of the carbon shown above, it is evident that it therefore exists in three different modifications, as follows:—

(1.) As graphitic carbon: in this condition it is insoluble in hot nitric acid (1·2 sp. gr.).
(2.) As a peculiar modification of carbon, capable of dissolving in hot nitric acid (1·2), and communicating the peculiar colouration on which Eggertz's colour test depends.
(3.) As a peculiar modification of—or, what is more probable, a definite compound of—carbon and iron, which dissolves in, or is otherwise decomposed by, hot nitric acid (1·2) *without communicating any colour whatever.*

The first and second forms exist in ordinary unhardened and unhammered steel: the first may be entirely, or at least partially, eliminated by hammering.

The third is an essential constituent of steel *after* it has been hardened, *not before*: the second also always exists to a certain extent.

The following are the amounts of the carbon in this state after the steel has been hardened in the samples examined, as shown by the difference of the colour test *plus* graphite and the result found by combustion:—

No. 1	0·51 per cent	Of carbon neither graphitic nor in the ordinary state as shown by Eggertz's colour test.
2	0·37 ,,	
3	0·37 ,,	
4	0·12 ,,	
5	0·29 ,,	
6	0·50 ,,	
A	0·31 ,,	
A hardened in oil	0·16 ,,	

Of course the carbon has already been divided into three states, named graphitic, cement, and hardening carbon respectively; but the above third form of carbon differs most decidedly from the hardening carbon here mentioned, because it is shown not to exist until the steel is hardened, while the theory is that it exists before hardening. (For instance, Prof. Akermann says—"Hammering favours the conversion of cement carbon into hardening carbon.")

Taking these results as they stand, the conclusion I come to is that iron forms a definite compound with carbon at high temperatures, and that because of its instability it gradually decomposes when the material in which it exists is submitted to slow cooling; and if the heat be

suddenly abstracted, the compound is prevented from decomposition. The more rapid the abstraction of heat the more of this compound there is left undecomposed, and the harder therefore will be the steel.

The theory which is, I believe, at present most favourably looked on as explaining the phenomena of hardening may be summed up as follows:—"The violent compression produced as a result of the sudden cooling causes the carbon to combine or enter into more intimate union with the iron." In opposition to this I place the following as one tending to a more satisfactory explanation:—"That the rapid abstraction of heat partially prevents the decomposition of an unknown unstable compound of iron and carbon, the presence of which compound communicates the peculiar properties of hardened steel."

Laboratory, Newburn Steel Works,
Newcastle-on-Tyne, August 23, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 5, August 2, 1880.

Preparation of Chlorine.—M. Berthelot.—The author has resumed the study of the reactions which ensue when chlorine is prepared in the ordinary manner. The facts observe prove that they are accompanied by phenomena of equilibrium in which the relative proportions of water, of hydrochloric acid, and of chlorine play an essential part. The formation of the brown soluble compound requires not merely the presence of chlorine and of manganese, but also of a decided excess of hydrochloric acid. The compound is perchlorinised hydrochlorate of manganese.

Heats of Combustion.—M. Berthelot.—The author considers that the researches of M. Thomsen, published in the *Berichte* of the German Chemical Society, confirm his own results.

Synthesis of Hexamethyl-benzine and of Mellic Acid.—C. Friedel and J. M. Crafts.—The authors have completed the oxidation of hexamethyl-benzine, thus obtaining mellic acid, and realising the synthesis of one of the most complex natural acids.

Researches on the Electric Effluve.—P. Hautefeuille and J. Chappuis.—The alternative discharge apparatus of M. Arn. Thénard are very suitable for showing the rain of electric fire in the different gases and under varied pressures. The phenomena in question are particularly distinct and brilliant in silicon fluoride. Next to this gas nitrogen presents the finest rain of fire. In oxygen the effluve is scarcely visible.

Researches on Batteries.—A. d'Arsonval.—The author has found two methods for obviating the inconvenience that chemical action in batteries is never entirely arrested when the circuit is open. One of these methods is based upon the absorbent power of animal charcoal, and is applicable to all the cases where the depolarising liquid is a metallic salt. He has constructed a sulphate of copper battery, in which the copper solution cannot be diffused through the zinc. He takes an ordinary Callaud element, at the bottom of which is placed a stratum of powdered copper sulphate, covered with bone-black, washed, and powdered. The zinc is placed in the upper part of the jar, and is separated from the copper sulphate by the bone-black. The element thus arranged resembles a Minotti battery, in which bone-black is substituted for sand. The zinc remains entirely unaffected. The second method, more general than the first, consists in taking as a depolarising body a liquid which gives a precipitate on mixture with the liquid which attacks the zinc. The diaphragm separating the two liquids is thus rendered completely impermeable. The precipitate formed in its pores must be a conductor of electricity and must be capable of electrolysis.

Researches on the Combustion-heats of Certain Bodies of the Fatty Series.—W. Louguinine.—A determination of the combustion-heats of allylic alcohol, ethyl-vinyl-carbinol, normal propylenic glycol, and isopropylenic glycol.

MISCELLANEOUS.

The British Association.—At the concluding meeting of the British Association at Swansea, Dr. Sclater, after having read the report of the General Committee, remarked that the Swansea meeting had not been successful, but then the greatest success was never expected in towns which were very far away from the great centres of population. So far as the excursions went they had laboured under an *embarras de richesses*, and several of the proposed parties had to be abandoned. The total number of tickets issued was 915, made up as follows:—Old life members, 144; new life members, 41; associates, 389; ladies, 147; and foreigners, 12. The total receipts were £899, as against £1736 received at Sheffield. The grants, amounting to £1010, were appropriated as follows:—Mathematics and Physics—Mr. G. H. Darwin, Lunar Disturbance of Gravity, £30; Professor Everett, Underground Temperature, £20; Professor Carey Foster, Electrical Standards, £100; Mr. James Glaisher, Luminous Meteors, £15; Dr. Joule, Mechanical Equivalent of Heat, £40; Dr. O. Lodge, High Insulation Key, £5; Professor Sylvester, Fundamental Invariations, £40; Sir William Thomson, Seismic Experiments, £30; Sir William Thomson, Tidal Observations, £10; Mr. J. M. Thomson, Inductive Capacity of Crystals and Paraffins, £10. Chemistry—Dr. Gladstone, Specific Refractions, £10; Lord Rayleigh, Spectrum Analysis, £10. Geology—Professor Duncan, Fossil Polyson, £10; Mr. J. Evans, Geological Record, £100; Professor E. Hull, Underground Waters, £10; Professor A. C. Ramsay, Earthquakes in Japan, £25; Dr. Sorby, Metamorphic Rocks, £10; Professor W. C. Williamson, Tertiary Flora, £20. Biology—Dr. M. Foster, Scottish Zoological Station, £50: Dr. M. Foster, Naples Zoological, £75; Lieutenant-Colonel Godwin Austen, Natural History of Socotra, £50; Mr. Gwyn Jeffreys, Exploration of Seabed North of the Hebrides, £50; General Pitt-Rivers, Anthropological Notes, £20; Dr. Pye-Smith, Elimination of Nitrogen during Bodily Exercise, £50; Professor Rolleston, Pre-Historic Remains in Dorsetshire, £25; Mr. Sclater, Natural History of Timorlant, £50; Mr. Stainton, Geological Record, £100. Economical Science and Statistics—Mr. F. Galton, Estimation of Weights and Heights of Human Beings, £30. Mechanics—Mr. Bramwell, Patent Laws, £5; Mr. James Glaisher, Wind Pressure on Buildings, £5; Professor Osborne Reynolds, Steering Steamships, £5. The meeting in 1881 will be held at York, where the first meeting, in 1831, was held, under the presidency of Sir John Lubbock, Bart., F.R.S.

NOTICE.

The STUDENTS' NUMBER of the CHEMICAL NEWS will be published on Friday, September 17th. Gentlemen holding official positions in the Universities, Colleges, Medical Schools, &c., of the United Kingdom, where Chemistry and Physical Science form a part of the education, who have not yet forwarded the necessary information to our Office for publication in that Number, will confer a favour by sending it with the least possible delay.

THE CHEMICAL NEWS.

Vol. XLII. No. 1086.

ADDRESS TO STUDENTS.

The duty or the policy—and the two are here identical—of a man entering upon any course of serious study is not as simple as was the case in former days. We refer not merely to the vastly increased extent of every science, to the enhanced accuracy now expected in all investigations, or to the rapid progress made in every department, which frequently compels us to revise before the end of the year views which we had adopted at its beginning. There is another and a more perplexing difficulty. Formerly, and even at present in some countries, the student had to keep in view one paramount object only. To whatever science he had devoted himself he had to make himself thoroughly master of its principles and its methods. The purpose of study was not so much to acquire a mere summary of what had already been discovered by others as to become capable of continuing their work and of adding to the stores of truth which they had accumulated. The power of effecting such continuations and of making such additions is surely the best, the all-sufficient, proof that the student's time has not been misspent.

But in higher education as conducted in modern England this unity of purpose no longer exists, and this test of proficiency is no longer accepted. The student is required not merely to make himself, if possible, thoroughly acquainted with his subject, but to satisfy certain official persons that he has obtained such an acquaintance. If he does not succeed in the latter object his actual proficiency in the science in question will be of no avail. And if a due knowledge of such science be a part of the preparation required for some professional career his time will have been in one sense wasted. Hence this latter object assumes the preponderance;—the shadow outweighs the substance, and, in the never-to-be-forgotten words of Prof. Huxley, we study in these days not to know but to "pass," the consequence being that we pass and don't know. The difficulty, then, placed before the British student is how to combine the two purposes: how, whilst qualifying himself to take a good position at an examination, he may at the same time become fitted for a career of research hereafter. We cannot, unfortunately, give any neat formula or recipe for compassing this object. But there are some considerations which may profitably be kept in mind. Let it be remembered that examinations are only a means, real or supposed, towards a certain end, not the end itself. When a man has got so far as to define, even in his secret thoughts, Science as a mere something to be examined in he is intellectually dead. In conjunction with this caution we must make a demand upon the moral nature of the student. We must exhort him, at whatever cost of time and labour, to eschew cram, including under the term all the tricks and dodges by which a really undisciplined mind is made to put on a false appearance of mastership. It is not safe to argue that the English system of examinations being essentially a sham it may be legitimately evaded. He who wins degrees and diplomas by deceit will have acquired habits of dishonesty which will cling to him in after life, and which will manifest themselves in a propensity for trimming and cooking results, for suppressing inconvenient facts and forging evidences for a tottering theory. He who cheats examiners in his youth will in after life be apt to cheat scientific societies and the learned world at large for his own glorification, and may perhaps for a time succeed.

If we might presume to address a word of advice to examiners we would recommend them, in place of reading up recondite matter in order to puzzle a student, to devise means for distinguishing true knowledge from mere cram, and intelligent comprehension of principles from the results of verbal memory.

UNIVERSITIES AND COLLEGES.

UNIVERSITY OF LONDON.

Candidates for any Degree granted by this University are required to have passed the Matriculation Examination, to which no candidate is admitted unless he has produced a certificate showing that he has completed his sixteenth year.

The Fee for this examination is £2.

The Examination will be held on Monday, January 10th, 1881. It is conducted by means of Printed Papers; but the Examiners are not precluded from putting, for the purpose of ascertaining the competence of the Candidates to pass, *viva voce* questions to any Candidate in the subjects in which they are appointed to examine.

Candidates are not approved by the Examiners unless they have shown a competent knowledge in each of the following subjects:—Latin. Any two of the following Languages:—Greek, French, German, and either Sanskrit or Arabic. The English Language, English History, and Modern Geography. Mathematics. Natural Philosophy. Chemistry.

The Papers in Latin and Greek will contain passages to be translated into English, with questions in Grammar and History and Geography arising out of the subjects of the books selected. Short and easy passages will also be set for translation from other books not so selected. A separate paper will be set containing questions in Latin Grammar, with simple and easy sentences of English to be translated into Latin.

Candidates may substitute German for Greek.

The papers in French and German will contain passages for translation into English, and questions in Grammar, limited to the Accidence. The paper in Sanskrit or Arabic will contain passages for translation into English, and questions in Grammar.

The examination in the English Language, English History, and Modern Geography includes Orthography; Writing from Dictation; the Grammatical Structure of the Language. History of England to the end of the Seventeenth Century.

That in Mathematics includes the ordinary Rules of Arithmetic; Vulgar and Decimal Fractions; Extraction of the Square Root. Addition, Subtraction, Multiplication, and Division of Algebraical Quantities; Proportion; Arithmetical and Geometrical Progression; Simple Equations. The First Four Books of Euclid, or the subjects thereof.

The Questions in Natural Philosophy are of a strictly elementary character; they include Mechanics, Hydrostatics, Hydraulics, Pneumatics, Optics, and Heat.

The Examination in Chemistry is—Chemistry of the Non-metallic Elements; including their compounds—

their chief physical and chemical characters—their preparation—and their characteristic tests.

A Pass Certificate, signed by the Registrar, will be delivered to each Candidate who applies for it, after the Report of the Examiners has been approved by the Senate.

If in the opinion of the Examiners any Candidates in the Honours Division of not more than Twenty years of age at the commencement of the Examination possess sufficient merit, the first among such Candidates will receive an Exhibition of thirty pounds per annum for the next two years; the second among such Candidates will receive an Exhibition of twenty pounds per annum for the next two years; and the third will receive an Exhibition of fifteen pounds per annum for the next two years; such exhibitions are payable in quarterly instalments, provided that on receiving each instalment the Exhibitioner declares his intention of presenting himself either at the two Examinations for B.A., or at the two Examinations for B.Sc., or at the First LL.B. Examination, or at the Preliminary Scientific and First M.B. Examinations, within three academical years* from the time of his passing the Matriculation Examination.

Under the same circumstances, the fourth among such Candidates will receive a prize to the value of ten pounds in books, philosophical instruments, or money; and the fifth and sixth will each receive a prize to the value of five pounds in books, philosophical instruments, or money.

Any Candidate who may obtain a place in the Honours Division at the Matriculation Examination in January is admissible to the First B.A. or to the First B.Sc. Examination in the following July.

First B.Sc. Examination.

The First B.Sc. Examination will be held in July, 1881.

No Candidate (with the exception of such as have obtained Honours at the Matriculation Examination in the preceding January) is admitted to this Examination within one academical year of the time of his passing the Matriculation Examination.

The Fee for this Examination is £5.

The Examination embraces the following subjects:—Pure and Mixed Mathematics, Inorganic Chemistry, Experimental Physics, and General Biology.

Examination for Honours.

Any Candidate who has passed the First B.Sc. Examination in all its subjects may be examined at the Honours Examination next following the First B.Sc. Examination at which he has passed for Honours in (1) Mathematics, (2) Experimental Physics, (3) Chemistry, (4) Botany, and (5) Zoology; unless he has previously obtained the Exhibition in Pure and Mixed Mathematics at the First B.A. Examination, in which case he will not be admissible to the Examination for Honours in that subject; or unless he has previously obtained an Exhibition at the Preliminary Scientific (M.B.) Examination in either of the subjects which are common to it with the first B.Sc. Examination, in which case he will not be admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry will be examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition, they will be examined practically in Simple Qualitative Analysis. This Examination, which will consist of six hours' examination by printed papers and of six hours' practical work, will take place on Thursday and Friday in the same week with the Examination for Honours in Mathematics, commencing on each day at 10 a.m.

In the Examination for Honours, the Candidate, not being more than 22 years of age at the commencement of the Pass Examination, who most distinguishes himself in Mathematics, will receive an Exhibition of £40 per annum for the next two years.

Second B.Sc. Examination.

The Second B.Sc. Examination will be held in October, 1881.

Candidates for this Examination are required to have passed the First B.Sc. Examination at least one academical year previously.

The Fee for this Examination is £5.

The regulations are framed with the view of allowing the candidate to select *any three* of the following nine subjects:—

1. Pure Mathematics.
2. Mixed Mathematics.
3. Experimental Physics.
4. Chemistry.
5. Botany, including Vegetable Physiology.
6. Zoology.
7. Animal Physiology.
8. Physical Geography and Geology.
9. Mental and Moral Science.

Examination for Honours.

Any Candidate who has passed the Second B.Sc. Examination, and has not previously passed the Second B.A. Examination, may be examined at the Honours Examination next following the Second B.Sc. Examination at which he has passed, for Honours in (1) Mathematics, (2) Mental and Moral Science, (3) Experimental Physics, (4) Chemistry, (5) Botany, (6) Zoology, (7) Physiology, (8) Physical Geography and Geology; provided that he shall have gone through the Pass Examination in the corresponding subject or subjects immediately before. And any Bachelor of Arts who has passed the Second B.Sc. Examination may under the same conditions be examined for Honours in one or more of the above mentioned subjects, unless he have previously obtained a Scholarship at the Second B.A. Examination in either of the first two of those subjects, in which case he shall not be admissible to the Examination for Honours in that subject.

The examination for Honours in Chemistry will take place on Monday and Tuesday in the week following the Examination for Honours in Mathematics; on Monday by printed papers (chiefly on Organic Chemistry), and on Tuesday by practical exercises in Simple Qualitative and Quantitative Analysis.

The candidate, being not more than 23 years of age, who most distinguishes himself in Chemistry, will receive £50 per annum for the next two years, with the style of University Scholar.

Doctor of Science.

The examination for the Degree of Doctor of Science takes place annually within the first twenty-one days of June, and the examination in each branch occupies four days.

No candidate is admitted to the examination for the Degree of D.Sc. until after the expiration of two Academical Years from the time of his obtaining the Degree of B.Sc. in this University, unless he shall have passed the Second B.Sc. Examination in the First Division at least two Academical years subsequently to having passed the first B.Sc. Examination, in which case he shall be admitted to the examination for the Degree of Doctor of Science at the expiration of *one* Academical Year from the time of obtaining his B.Sc. Degree.

The Fee for this Examination is £10.

Every candidate for the degree of D.Sc is examined in some one or more of the various branches of Physical,

* By the term "Academical Year" is ordinarily meant the period intervening between any Examination and an Examination of a higher grade in the following year; which period may be either more or less than a Calendar year. Thus the interval between the *First* Examinations in Arts, Science, and Medicine, and the *Second* Examinations of the next year in those Faculties respectively, is about sixteen months, whilst the interval between the Second B.A. Examination and the M.A. Examination of the next year, or between the Second B.Sc. Examination and the D.Sc. Examination of the next year, is less than eight months. Nevertheless, each of these intervals is counted as an "Academical Year."

Biological, or Mental Science, to be selected by himself; and no candidate is approved by the examiners unless he has shown a thorough practical knowledge of the principal subject and a general acquaintance with the subsidiary subject or subjects, specified as belonging to the branch so selected. He is expected to be so fully conversant with the principal subject he may select as to be able to go through any examinational test (whether theoretical or practical) of his acquirements in it that can be fairly applied. Candidates, when giving notice, must specify the branch or branches in which they desire to be examined.

Branch IV. of Physical Science. Inorganic Chemistry.

Principal Subject—Inorganic Chemistry.

Subsidiary Subject—Either Organic Chemistry; or Mineralogy, Crystallography, and Chemical Technology in its relations to Inorganic Chemistry.

Branch V., Organic Chemistry.

Principal Subject—Organic Chemistry.

Subsidiary Subjects—Either Inorganic Chemistry; or Chemical Technology in its relations to Organic Chemistry, and the Chemistry of Animal and Vegetable Life.

Preliminary Scientific (M.B.) Examination.

This examination will be held in July, 1881.

No Candidate is admitted to this examination until he has completed his seventeenth year, and has either passed the Matriculation Examination* or taken a Degree in Arts in one of the Universities of Sydney, Melbourne, Calcutta, or Madras (provided that Latin was one of the subjects in which he passed). The fee for this examination is five pounds.

Candidates for the degree of M.B. are strongly recommended by the Senate to pass the Preliminary Scientific Examination before commencing their regular medical studies; and to devote a preliminary year to preparation for it according to the following programme:—Winter Session: Experimental Physics; Chemistry (especially Inorganic); Zoology. Summer Session: Practical Chemistry (Inorganic); Botany.

Any candidate who has passed the Preliminary Scientific (M.B.) Examination, may be examined at the Honours Examination next following the Preliminary Scientific Examination at which he has passed, unless he has previously obtained an Exhibition in any one of the subjects at the First B.Sc. Examination, in which case he is not admissible to the Examination for Honours in that subject.

Candidates for Honours in Chemistry are examined in Inorganic Chemistry, treated more fully than in the Pass Examination. In addition they are examined practically in Simple Qualitative and Quantitative Analysis.

Examination in Subjects relating to Public Health.

A Special Examination will be held in December in subjects relating to public health.

No candidate is admitted to this Examination unless he has passed the Second Examination for the Degree of Bachelor of Medicine in ths University at least one year previously; nor unless he shall have given notice of his intention to the Registrar at least two calendar months before the commencement of the Examination.

The Fee for this Examination is £5.

Candidates are examined in the following subjects:—

Chemistry and Microscopy, in relation to the examination of Air, Water, and Food.

Meteorology and Geology, as far as they bear on the duties of Health Officers, viz.:—General knowledge of Meteorological Conditions; Reading and Correction of Instruments. General knowledge of Soils; their Conformation and Chemical Composition.

Vital Statistics, in reference to the methods employed for determining the Health of a Community; Birth-rate; Death-rate; Disease-rate; Duration and of Expectancy of Life. Present amount of Mortality, and its causes, in different Communities.

Hygiene.—General principles of Hygiene. Special topics:—Soil. Construction of Dwellings. Conservancy of Cities. Unhealthy Trades. Supply of Food to Cities, and Examination of Food. Disposal of Sewage. Water-supply.

Medicine, in reference to the origin, spread, and method of prevention of Diseases generally, but especially those of the Epidemic class.

Sanitary Engineering, as far as regards the arrangements connected with Water-supply, Sewerage, and Ventilation. A knowledge of the reading of Plans, Sections, Scales, &c.

Sanitary Law, as far as it relates to the duties of Officer of Health. A knowledge of the powers given under the various Sanitary Acts, as defined in the Instructions issued by the Local Government Board, and of the methods of procedure in special cases.

The Examination, which is both written and practical, extends over four days.

Gilchrist Scholarships.

1. A Scholarship of the value of Fifty Pounds per annum, and tenable for three years, is annually awarded to the Candidate from the Royal Medical College, Epsom, who at the June Matriculation Examination stands highest among the Candidates approved by the Head Master of that Institution, and who passes either in the Honours List or in the First Division; on condition of his prosecuting his studies during the tenure of his Scholarship with a view to Graduation in one of the Faculties of the University of London.—Particulars may be obtained on application to the Secretary of the Royal Medical College, 37, Soho Square, W.

2. A similar amount is annually offered to Candidates intending to pursue, at Owens College, Manchester, their studies for Graduation in one of the four Faculties of the University of London; a single Scholarship of Fifty Pounds per annum for three years being awarded to the highest of those Candidates at the June Matriculation Examination who shall have been previously approved by the Principal of Owens College, provided that he pass in the Honours Division; or, in case no Candidate should so pass, two Scholarships, each of Twenty-five Pounds per annum, being awarded to the two Candidates as aforesaid who shall stand highest in the First Division.—Particulars may be obtained on application to the Principal of Owens College, Manchester.

Particulars of the Colonial and Indian Scholarships may be obtained on application to the Secretary of the Gilchrist Educational Trust, 4, Broad Sanctuary, Westminster, S.W.

SCIENCE AND ART DEPARTMENT OF THE COMMITTEE OF COUNCIL ON EDUCATION, SOUTH KENSINGTON.

A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom. The object of the grant is to promote instruction in Science, especially among the industrial classes, by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.

In order to place a science school or class in connection with the Science and Art Department, an approved committee, consisting of at least five well known and responsible persons, must be formed.

* Candidates who pass in all the subjects of the Preliminary Scientific (M.B.) Examination, and also pass *at the same time* in the Pure Mathematics of the First B.Sc. Examination, or who have previously passed the First B.A. Examination, are considered as having passed the First B.Sc. Examination. The attention of such candidates is directed to the fact that, under the new regulations for the B.Sc. Degree, this degree may be obtained by passing at the Second B.Sc. Examination in the three Biological subjects only.

The following are the sciences towards instruction in which aid is given by the Science and Art Department:—Practical, Plane, and Solid Geometry; Machine Construction and Drawing; Building Construction; Naval Architecture and Drawing; Pure Mathematics; Theoretical Mechanics; Applied Mechanics; Sound, Light, and Heat; Magnetism and Electricity; Inorganic Chemistry; Organic Chemistry; Geology; Mineralogy; Animal Physiology; Elementary Botany; Biology, including Animal and Vegetable Morphology and Physiology; Principles of Mining; Metallurgy; Navigation; Nautical Astronomy; Steam; Physiography; Principles of Agriculture.

The aid is given in the form of—1. Public examinations in which Queen's Prizes are awarded, held at all places, complying with certain conditions; 2. Payments on results as tested by these examinations; 3. Scholarships and Exhibitions; 4. Building grants; 5. Grants towards the purchase of fittings, apparatus, &c.; 6. Supplementary grants in certain subjects, and special aid to teachers and students.

The examinations are held about the month of May under the superintendence of the local committees and local officers. The examination papers are prepared by the professional examiners in London. An evening is set apart for one or more subjects, so that the examination in each subject is simultaneous over the whole kingdom.

A packet of examination papers is sent to each local examination secretary, who opens it in the presence of the committee and candidates. The committee is held responsible that no unfair means of any description are used in working the papers, and that the rules of the Department are strictly complied with.

The examinations are of two kinds, but held together, viz.—

a. The Class examinations, of which there are two grades or stages; the first stage or elementary examination, and the second stage or advanced examination. The successful candidates in both stages are divided into 1st and 2nd class.

b. The Honours examination of a highly advanced character. In this there are also two classes.

Any person however taught may sit at any one of these examinations.

Queen's prizes, consisting of books or instruments, are given to all candidates who are successful in obtaining a first class in either stage of the class examinations, and Bronze Medals to those who obtain a first class in Honours.

The payments on results are made only on account of the instruction of students of the industrial classes, or on account of the instruction of their children. They are—£2 for a first class, and £1 for a second class, in each stage of the class examinations, and £2 and £4 for a second or first class respectively in honours. Special extra payments are made in attendance in organised Science Schools. Special payments are also made for Chemistry.

There are also two forms of scholarship in connection with elementary schools.

a. In the Elementary School Scholarship £5 are granted to the managers of any elementary school for the support of a deserving pupil selected by competition, if they undertake to support him for a year and subscribe £5 for that purpose. The payment of £5 by the Science and Art Department is conditional on the scholar passing in some branch of science at the next May examination.

b. In the Science and Art Scholarship, which is of a more advanced character, a similar contribution of £5 is required on the part of the locality, and a grant of £10 is made by the Department towards the maintenance, for one year, of the most successful pupil or pupils in elementary schools who have passed certain examinations in science and in drawing.

In the first case the scholar must be from twelve to sixteen, and in the latter from twelve to seventeen years of age. One scholarship is allowed per 100 pupils in the school. Thus a school with 50 pupils may have one scholarship, a school with 150 pupils two scholarships.

There are also two forms of Exhibitions. These are:—

a. Local Exhibitions to enable students to complete their education at some college or school where scientific instruction of an advanced character may be obtained. Grants of £25 per annum, for one, two, or three years are made for this purpose when the locality raises a like sum by voluntary subscriptions. And if the student attend a State School, such as the Royal School of Mines in London, the Royal College of Chemistry in London, or Royal College of Science in Ireland, the fees are remitted. The exhibition must be awarded in competition.

b. Royal Exhibitions of the value of £50 per annum tenable for three years, to the Royal School of Mines, London, and the Royal College of Science, Dublin, are given in competition at the May examinations. Six are awarded each year—three to each institution. The exhibitions entitle the holder to free admissions to all the Lectures, and to the Chemical and Metallurgical Laboratories at those two institutions.

The competition for the Whitworth Scholarships, tenable for three years, is also in part determined by the results of the May examinations.

A grant in aid of a new building, or for the adaptation of an existing building, for a School of Science may be made at a rate not exceeding 2s. 6d. per square foot of internal area, up to a maximum of £500 for any one school, provided that certain conditions are complied with and that the school be built under the Public Libraries and Museums Act, or be built in connection with a School of Art, aided by a Department building grant.

A grant towards the purchase of fittings, apparatus, diagrams, &c., of 50 per cent of the cost of them is made to Science Schools.

Special extra grants in the form of capitation payments are made in fully organised Science Schools.

UNIVERSITY OF OXFORD.

Waynflete Professor of Chemistry.—W. Odling, M.A., F.R.S.

Professor of Mineralogy.—N. S. Maskelyne, M.A., F.R.S.

Every Student must reside in one or other of the Colleges or Halls, or in licensed lodgings, for a period of three years, passing at least two examinations in Arts, and one in either Mathematics, Natural Science, Law, Modern History, or Theology, when, if he obtain a first, second, or third class, he can take his B.A. Degree; if he do not gain such honour he has to pass a third examination in *Literis Humanioribus*.

The fee for students working in the Laboratory for three days in the week during the Term is £3; for students working every day, £5.

Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other colleges, by competitive examination in Natural Science.

More detailed information may be obtained from the University Calendar; from the professors; from E. Chapman, Esq., M.A., Frewin Hall; and from the Sub-Librarian in the Radcliffe Library or the Museum.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. D. Liveing, M.A., F.R.S.

Jacksonian Professor of Natural and Experimental Philosophy.—J. Dewar, M.A., F.R.S.

Demonstrators.—J. W. Hicks, M.A., W. J. Sell, B.A., and H. J. H. Fenton, B.A.

The Student must enter at one of the Colleges, or as a Non-collegiate Student, and keep terms for three years by residence in the University. He must pass the previous examination in Classics and Mathematics, which may be done in the first or second term of residence, or, through the Oxford and Cambridge Schools Examination Board, or through the Senior Local Examinations, before

commencing residence. He may then proceed to take a Degree in Arts, either continuing mathematical and classical study, and passing the ordinary examinations for B.A., or going out in one of the Honour Triposes.

The scholarships, ranging in value from £20 to £80 a year, are chiefly given for mathematical and classical proficiency. Scholarships are given for Natural Science in Trinity, St. John's, St. Peter's, Clare, Christ's, Sidney, Pembroke, Caius, and Downing Colleges; the examinations being at Easter, and in June and October.

The Chemical Laboratory of the University is open daily for the use of the Students. The Demonstrators attend daily to give instructions.

Non-collegiate Students are allowed to attend certain of the College Lectures and all the Professors' Lectures, and have the same University status and privileges as the other Students. They are under the superintendence of the Rev. R. B. Somerset, Orford House, Cambridge, from whom further information may be obtained.

The following are the Lectures on Chemistry for the ensuing Academical Year: —

Michaelmas Term, 1880.

General Course, by the Professor of Chemistry, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Oct. 13.

Spectroscopic Analysis, by the Professor of Chemistry, on Mondays, Wednesdays, and Fridays, at 1.30 p.m. Begin Oct. 18.

Analysis, by the Professor and the Demonstrators of Chemistry. Daily. Begin Oct. 13. Also at St. John's College, by Mr. Main. Begin Oct. 13. Also at Caius College, by Mr. Pattison Muir; begin Oct. 18. Also at Sidney College. Begin Oct. 12.

Metals, by Mr. Pattison Muir. Monday, Wednesday, and Friday, at 10. Begin Oct. 18.

Physical Chemistry, by the Jacksonian Professor, on Tuesdays, Thursdays, and Saturdays, at 11. Begin Oct. 14.

Elementary Organic Chemistry, by Mr. Main, at St. John's College, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 14.

Volumetric Analysis, by a Demonstrator, on Tuesdays, Thursdays, and Saturdays, at 10 a.m. Begin Oct. 14.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin Oct. 14.

Electricity and Electro- Magnetism, by the Professor of Experimental Physics, on Mondays, Wednesdays, and Fridays, at 1 p.m. Begin Oct. 13.

Lent Term, 1881.

General Course continued, by the Professor of Chemistry, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin Feb. 2.

Analysis, by the Professor or Demonstrators of Chemistry. Daily. Begin Jan. 19. Also at St. John's College. Begin Jan. 31. Also at Caius College Laboratory. Begin Feb. 2. Also at Sidney College Laboratory. Begin Feb. 2.

Organic Chemistry, by the Jacksonian Professor, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin Feb. 3.

General Course, begun by Mr. Main, at St. John's Laboratory, on Tuesdays, Thursdays, and Saturdays, at 11 a.m. Begin Feb. 1.

Non-metallic Elements, by Mr. Pattison Muir, at Caius Laboratory, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Feb. 2.

Catechetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin Feb. 31.

Electricity and Magnetism, by Mr. Trotter, at Trinity College, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin Feb. 4.

Easter Term, 1881.

Some Special Department, by the Professor of Chemistry, on Tuesdays and Saturdays, at 12 noon. Begin May 3.

Analysis, by the Professor or Demonstrators of Chemistry. Daily. Begin April 25. Also at St. John's College. Begin May 2. Also at Caius College. Begin April 27. Also at Sidney College Laboratory. Begin April 27.

Elementary Chemistry, by a Demonstrator of Chemistry, on Mondays, Wednesdays, and Fridays, at 3 p.m. Begin May 2.

General Course concluded, by Mr. Main, at St. John's Laboratory, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin April 27.

Elementary Organic Chemistry and Analysis, by Mr. Pattison Muir, at Caius Laboratory, on Mondays, Wednesdays, and Fridays, at 10 a.m. Begin April 27.

Catec hetical Lectures, by Mr. Lewis, at Downing College, on Mondays, Wednesdays, and Fridays, at 9 a.m. Begin April 23.

Inorganic Chemistry, Catechetical Lectures, by Mr. Walker, on Mondays, Wednesdays, and Fridays, at 12 noon. Begin April 27.

Electricity and Magnetism, by the Professor of Physics, at Cavendish Laboratory, on Tuesdays, Thursdays, and Saturdays, at 12 noon. Begin in April.

Long Vacation (July and August), 1881.

Practical Physics, in the Cavendish Laboratory.

Practical Chemistry, in the University Laboratory.

UNIVERSITY OF DUBLIN.—TRINITY COLLEGE.

The Chemical Laboratory will re-open on October 1st, 1880, with complete working accommodation for upwards of 100 students.

The University Professor of Chemistry, Dr. Emerson Reynolds, F.R.S., assisted by the Demonstrator of Chemistry, Mr. Early, conducts the undermentioned Courses of Laboratory instruction:—

The First Course of Practical Chemistry.—Michaelmas Term:—Qualitative Analysis and the Use of the Spectroscope. Hilary Term: Volumetric and Simple Gravimetric Analysis. Trinity Term: Organic Preparations and Analysis.

Students can also attend the Professor's Lectures on General Chemistry, and repeat most of the experiments performed in the Theatre.

This Course terminates on the last day of June.

The Second or Advanced Course includes instruction in the higher branches of Experimental and Analytical Chemistry, and in Methods of Research. Students who take out this Course are free to devote their chief attention to the study of special departments of Chemistry as applied to Arts and Industries.

Summer Course of Practical Chemistry for Medical Students.—This Course commences on the first Monday in April and terminates on the 30th of June following. Students experiment in the Laboratory from 2 to 4 o'clock on Tuesdays, Thursdays, and Saturdays.

Special Courses.—Students can enter at any time throughout the academic year for short terms of Laboratory instruction in Medical or Pharmaceutical Chemistry, or in the Methods of Analyses of Water, Air, &c., for Sanitary Purposes.

Lectures in Medical and Pharmaceutical Chemistry.—Dr. Reynolds lectures at 2 o'clock on Tuesdays, Thursdays, and Saturdays, from the 1st of November to the 31st of March following.

All the classes are open to extra-Academic Students.

KING'S COLLEGE.

(Department of Engineering and Applied Science.)

Professor of Chemistry.—C. L. Bloxam, F.C.S.

Demonstrator of Practical Chemistry.—J. M. Thomson, F.C.S.

Assistant Demonstrator.—G. S. Johnson, F.C.S.

On Tuesday and Friday at 10.20 a.m. Students of the First Year are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a View of the Forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic elements and their principal Compounds are described.

The Metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts; and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examinations of the Class, both *vivâ voce* and by written papers, are held at interval during the course at the usual Lecture hour.

Second Year.—Students attend in the Laboratory twice a week, on Tuesday and Friday, at 10.20, and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this Department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of extra Fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own Experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

Special hours and fees are arranged for the convenience of such Third Year Students as wish to study Analytical Chemistry.

Fees.—Chemistry per term, £3 3s. 0d.; per ann., £8 8s. 0d.; Practical Chemistry per term, £4 4s. 0d.; per ann., £10 10s. 0d.; Experimental and Analytical Chemistry—One Month (daily attendance), £4 4s. 0d.; Three Months (daily attendance), £10 10s. 0d.; Six Months (daily attendance), £18 18s. 0d.; Nine Months (daily attendance), £26 5s. 0d. A student taking a month's ticket may attend daily during 1 month, or 3 days a week during 2 months, or 2 days a week during 3 months.

Rules as to Admission of Students.

I. The Academical Year consists of Three terms: Michaelmas Term, from beginning of October to the week before Christmas; Lent Term, from the middle of January to the week before Easter; Easter Term, from Easter to the beginning of July.

II. The days fixed for the Admission of New Students in the Academical Year 1880-81, are Tuesday, October 5, Wednesday, January 12, and Wednesday, April 27.

UNIVERSITY COLLEGE.

FACULTY OF SCIENCE.

Chemistry.—Professor Williamson, Ph.D., F.R.S.

I. GENERAL COURSE.

Lectures daily (except Saturday) from 11 to 12 a.m., up to the last week in March.

Exercises on Tuesdays, Wednesdays, Thursdays, and Fridays, from 9 to 10 a.m.

Fees for the Course, £7 7s.; Perpetual, £9 9s.; for the Half Course, £4 4s.; for the Organic Course alone, £2 2s.

Fee for the Exercise Class, £2 2s.

The instruction in this Class is of two kinds, consisting partly of Experimental Lectures by the Professor, partly of Exercises and personal instruction on the subject of the Lectures by an Assistant.

Attendance on the Exercise Class (conducted by Mr. Temple A. Orme, F.C.S.) enables Students to do their work more effectually and rapidly than they can do it by themselves.

A. *The first half* of the course, to Christmas, includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

B. *The second half* of the Course, from January to March, includes the following subjects:—

1. Preparation and properties of the chief *Metals*, including their characteristic reactions and most important salts. Detection of metallic poisons. Quantitative estimation of metals. Principles of classification. Monatomic, diatomic metals, &c.

Organic Chemistry commences in the second week in February, and occupies five Lectures weekly till about the end of March. It includes a study of the characteristics and metamorphoses of the chief organic acids, bases, alcohols, ethers, colouring-matters, &c. Methods of ultimate and proximate analysis. Determination of molecular weights. Theory of types; of compound radicals. Phenomena of fermentation, &c.

Training of Teachers.

Teachers of Chemistry are trained in the theory and practice of their profession. A two years' Course is absolutely requisite for this purpose; but Students will with advantage devote a longer period to it.

The first year is occupied with attendance on the Courses of Chemistry and of Analytical Chemistry. In the second year the Student again attends the Course of Chemistry, and is intrusted with teaching-work in conjunction with the Tutors of the class. At the same time he continues to work in the Laboratory at analysis and original research.

In order to qualify themselves for rising to the higher ranks of the Profession, gentlemen remain for a further period, in which case they may obtain remunerative work in teaching through the recommendation of the Professor.

It must not, however, be supposed that a study of Chemistry alone, however complete, is sufficient to qualify a man to teach the Science effectively. A competent knowledge of Physics, Mathematics, and either French or German must necessarily be acquired at some period of the Student's Course.

II.—ANALYTICAL AND PRACTICAL CHEMISTRY.

A. Birkbeck Laboratory.

Assistants.—C. A. Bell, B.A., M.B., and H. Forster Morley, M.A., B.Sc.

When accompanied or preceded by attendance on the lectures on Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to the Manufacturing Arts, Metallurgy, Medicine, or Agriculture, &c. Instruction is given in the principles and processes of gas-analysis.

The Laboratory and offices are open daily from 9 a.m. to 4 p.m., from the 6th of October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees, for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

A Gold Medal and Certificates of Honour are competed for by students entered for the session.

B.—SUMMER PRACTICAL COURSES.

Chemical Theatre.

1. *Elementary Course.* (*Men.*)—About Forty Lessons, of one hour each, commencing in the first week of May.

The first six weeks of the Course are occupied by the study of the chief non-metallic elements and their simple compounds. Metallic salts, &c., are subsequently studied

Fees—including the cost of materials and apparatus: for the Course, £5 5s.; for a Second Course, £3 3s.

2. *Senior Course.* (*Men.*)—This Course consists of Twenty Lessons of two hours each, commencing in the first week in May.

The first half of the Course includes tests for fixed and volatile organic acids, nitrogenised acids, sugars, glycerin, alkaloids, &c.

The second half of the Course includes tests for mineral poisons in organic mixtures; also tests for organic bodies, such as alkaloids, when mixed with other organic substances.

Volumetric methods of the quantitative analysis of sugar and urea, chlorides, phosphates, hardness of water, alkalimetry, are practised.

Analysis of milk and ashes of blood.

Fees—including cost of materials and apparatus: for the Course, £5 5s.; for a Second Course, £3 3s.

III.—SUMMER MATRICULATION COURSE. (*Men.*)

TEMPLE A. ORME, F.C.S.

This Course includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

The Course consists of about Twenty Lessons in Practical Chemistry, and of an equal number of oral lessons. These lessons will begin on March 30th, 1881, at 11.

Fee, including cost of materials and apparatus, £4 4s.

ELEMENTARY CHEMISTRY.

Chemical Theatre. (*Women*).

Lectures—Wednesday and Friday, from 4 to 5.

A Class of Elementary Chemistry, including the subjects required for Matriculation, will be given during the Winter Session by C. A. Bell, B.A., M.B., Chief Assistant in the Chemical Laboratory, commencing Wednesday, October 13.

The instruction will consist partly of Lectures, partly of Laboratory Experiments performed by the Students.

Fees for the Course, including use of apparatus and materials, £4 4s.

Chemical Technology.

Professor CHARLES GRAHAM, D.Sc., F.I.C.

Assistant.—C. J. Wilson, F.C.S.

The Course of instruction in this Department is designed to afford to Students who propose to devote themselves to industrial pursuits in which Chemistry plays an important part, or to prepare themselves for the profession of Consulting Chemist, the instruction essential for their success in their future line of work. It will also be found of great value in two of the branches (Organic and Inorganic Chemistry) in which the Degree of Doctor of Science can be taken at the University of London.

Assuming that the Student enters for a three years' study, the following will give an idea of the nature of the work during the period:—

In the first year the Student will attend Lectures on Theoretical Chemistry, and work at Analytical Chemistry in the Chemical Laboratory, and will also attend Lectures on Mathematics, Mechanics, and Physics. The Mechanical Drawing Class should also be attended during the first year by all Students.

In the second year, the Student will again attend the Lectures on Theoretical Chemistry, and will begin his study of Applied Chemistry by attendance on the Lectures in this subject, and by practical work in the Laboratory on the applications of Chemistry.

The third year will also be chiefly occupied with attendance on the Lectures on Chemical Technology, and in practical work connected therewith in the Laboratory.

In the second and third years the Student will, in addition to the foregoing subjects, which are common to all, attend Lectures and work at such other branches of Pure and Applied Science as may be deemed advisable after consultation with the Professor.

Students entering the College with more advanced scientific knowledge will be able to shorten the Course described to two years, or even one year, as may be found advisable.

For the convenience of those already engaged in business, and of those from other causes prevented from entering for a longer period of study, it is arranged that they can attend a Course of Lectures upon any one subject of Applied Chemistry without being required to attend any other lectures, either in Applied Chemistry or in other subjects.

In the Session 1881-82, it is proposed to treat of the following subjects:—

(1) The Chemistry of the Alkali trade.
(2) Soap, Glass, Pottery, Cements.
(3) Chemistry of Brewing.
(4) Agricultural Chemistry.

Should a sufficient number of Students desire a Course of Lectures on some subject of Applied Chemistry other than those above mentioned, the Professor will give such either in lieu of, or in addition to, those mentioned.

Students desirous of working at subjects not included in the foregoing Courses, such as Photography and Photographic materials, Paper-making, Gas-tar products, the products of the Distillation of Wood, Tanning, and other Chemical industries, will receive individual instruction in the Laboratory.

Fees—for each Course, £2 2s.; for the four Courses together, £5 5s.

Chemical Laboratory.

The instruction in the Laboratory in Chemical Technology, will consist of the examination and valuation of raw materials used, and of the final products obtained, in various manufacturing industries, and of experimental examination of the processes employed in the arts and manufactures.

The Laboratories are open daily from 9 a.m. to 4 p.m., from the 6th of October until the middle of July, with a short recess at Christmas and at Easter. Saturday, from 9 to 2.

Fees—for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials.

ROYAL SCHOOL OF MINES.

The mode of instruction at the Royal School of Mines is by systematic Courses of Lectures, by written and oral examinations, by practical teaching in the Laboratories, in the Drawing Office, and in the Field.

To become Associates at the Royal School of Mines it is necessary to pass through the following course of study:—

1st Year—Inorganic Chemistry, with practice in laboratory; Mechanical Drawing, both terms.

2nd Year—1st Term, Applied Mechanics and Physics, with practice in Laboratory. 2nd Term, Mineralogy; Mechanical Drawing, both terms.

3rd Year (Mining Division)—1st Term, Mining; Assaying. 2nd Term, Geology, with practice in laboratory and field. Metallurgical Division, 1st and 2nd Terms—Metallurgy, with practice in laboratory. Geological Division, 1st Term—Natural History, with practice in laboratory. 2nd Term—Geology, with practice in laboratory and field; Palæontological Demonstrations.

The courses of instruction are distributed over three years, but those students who possess sufficient knowledge may, if they think fit, pass through the whole in two years, by presenting themselves during the current year for examination in the subjects allotted to the first and second years.

Students desirous of obtaining the distinction of Associate of the Royal School of Mines, who have already acquired a knowledge of the subjects of the first two years, may proceed at once to the courses of the third year, by passing the final class examinations in those subjects before the Professors of the Royal School of Mines, and paying a fee of £1 for each examination.

During the Session 1880-81 the following courses of Lectures will be delivered:—

40 Lectures on Inorganic Chemistry, commencing Oct. 4, 1880; 30 Lectures on Organic Chemistry, commencing Jan. 17, 1881, by E. Frankland, F.R.S.

80 Lectures on Biology, by T. H. Huxley, LL.D., F.R.S., commencing Oct. 4, 1880.

36 Lectures on Applied Mechanics, by T. M. Goodeve, M.A., commencing Oct. 4, 1880.

60 Lectures on Physics, by F. Guthrie, F.R.S., commencing Nov. 23, 1880.

50 Lectures on Metallurgy, by W. Chandler Roberts, F.R.S., commencing Oct. 4, 1880.

60 Lectures on Mining, commencing Nov. 8, 1880, and 40 Lectures on Mineralogy, commencing Feb. 21, 1881, by W. W. Smyth, M.A., F.R.S.

50 Lectures on Geology, by John W. Judd, F.R.S., commencing Feb. 14, 1881.

20 Lectures on Mechanical Drawing, by J. H. Edgar, M.A., commencing Oct. 9, 1880.

The Lectures on Chemistry, Physics, Mechanics, Biology, Geology, Metallurgy, and Mechanical Drawing are delivered at the Science Schools, South Kensington, where instruction is also given in the Laboratories. The Lectures on Mineralogy and Mining are given at the School of Mines in Jermyn Street, where the Metallurgical Laboratory is situated.

The Laboratories for instruction in chemical manipulation, in qualitative and quantitative analysis, the technical application of analysis, and in the method of performing chemical researches, are under the direction of Dr. Frankland, and will be opened on Friday, October 1, 1880.

The charge for instruction in the Chemical Laboratory is £12 for three months, £9 for two months, and £5 for one month.

The Metallurgical Laboratory is conducted by the Instructor in Assaying, Mr. R. Smith, in consonance with the views of the Lecturer, and is devoted to practical instruction in Metallurgy, especially in Assaying. The nature of this instruction will be adapted to the special requirements of the Student. It comprises:—Assaying in all its branches, especially of the more important metals, such as iron, copper, lead, tin, alloys of silver and gold, &c.; and the examination of fuel, fire-clay, ores, and metallurgical products.

The ability of the Student to make trustworthy assays is in every case thoroughly tested; and no certificate of competency is given to a Student who has not furnished satisfactory proof that he is able to obtain trustworthy results.

The charge for instruction in the Metallurgical Laboratory is £12 for three months, £9 for two months, and £5 for one month.

Lectures to Working Men.—Short Courses of Lectures at suitable periods of the year are given in the evening to Working Men. These courses are systematic, and arranged so as to illustrate, within a period of two years, the principal subjects taught at the institution. Those for the ensuing Session include Chemistry, Mineralogy, Applied Mechanics.

The following Exhibitions, Scholarships, and Prizes are awarded in connection with the School:—

Nine Royal Exhibitions, each of £50 per annum, three of which are competed for annually at the May examinations of the Department of Science and Art.

Two Royal Scholarships of £15 each to the best students of the first year; and One Royal Scholarship of £25 to the best second year's student.

The Edward Forbes Medal and Prize for Biology and Palæontology; the De la Beche Medal for Mining; and the Murchison Medal and Prize for Geology.

The public will be admitted to the lectures on payment of £4 for each course of 40 or more lectures, and £3 for the course of 30 and under 40 lectures.

The fee for students desirous of becoming Associates is £30 in one sum on entrance, or two annual payments of £20 each. Students presenting themselves for re-examination must pay a fee of £1 for each subject.

Persons who have taken either a first or a second class certificate in the advanced stage in any subject in science at the examinations held by the Science and Art Department, and who show that they are *bona fide* Science Teachers, may attend the Day Lectures gratuitously, provided that they be examined in at least one subject, paying a fee for such examination of £1 per course.

Perpetual Tickets are issued, which entitle the holder to attend all present and future courses of lectures upon payment of £40.

Officers of the Army and Navy, Her Majesty's Consular and Diplomatic Officers, Officers of the Crown at home on furlough, and acting Mine Agents and Managers of Mines, are admitted to the Lectnres at half the above charges.

UNIVERSITY OF ABERDEEN.

Professor of Chemistry.—J. S. Brazier, F.C.S.

I. *Systematic Course.*—The Lectures are delivered on the first five days of each week during the College session. They commence with the discussion of the General Principles of Chemical Philosophy, including the Atomic Theory and the Chemical Relations of Heat. The Non-metallic and Metallic Elements and their Compounds are fully treated of, together with their more important applications to the Arts. The latter part of the course is devoted to the subject of Organic Chemistry. Examinations are held at fixed periods during the Session. The fee is £3 3s.

II. *Practical Course.*—This course is given during the Summer Session. It is chiefly devoted to practice in Qualitative Analysis, with the view of enabling the Student to test unknown substances, poisons, the animal secretions, &c. The fee is £3 3s.

III. *Laboratory Pupils.*—The Chemical Laboratory is open during the College Session on the first five days in each week, from 10 a.m. till 3 p.m. The course of instruction is under the direction of the Professor of Chemistry and of the Teaching Assistant.

UNIVERSITY COLLEGE, BRISTOL.

Professor of Chemistry.—W. Ramsay, Ph.D.
Lecturer.—D. Orme Masson, M.A., B.Sc.

Inorganic Chemistry.

This Course treats of the principles of Chemistry, and of the Chemistry of the Non-Metals and Metals.

Lectures will be given at 10 o'clock on Mondays, Wednesdays, Fridays, and Saturdays during the First and Second Terms; the last of these being a tutorial lecture, which will deal with points requiring detailed explanation.

The lectures will be illustrated with experiments and diagrams.

Examinations will be held from time to time during the courses.

Fee, £4 4s. for two Terms, £3 3s. for one Term.

Technical Chemistry.

Lectures will be given during the First and Second Terms on Thursdays at 11, on Manufacturing and Metallurgical Processes with which Chemistry has specially to deal.

Fee, £2 2s.

Organic Chemistry.

This Course will relate to the more important groups of the Compounds of Carbon.

Lectures will be given during the Second Term on Tuesdays and Thursdays at 10 o'clock; during the Third Term on Tuesdays, Thursdays, and Saturdays at 10 o'clock.

Fee, £3 3s.

Practical Chemistry.—Laboratory Instruction.

The Laboratory will be open daily from 10 a.m. to 5 p.m., except on Saturdays, when it will close at 1 p.m. Instruction will be given in the Laboratory in all branches

of Practical Chemistry, including Qualitative and Quantitative Inorganic and Organic Analysis, the preparation of Chemical Products, and Inorganic and Organic Research. Special facilities will be afforded to those who desire to study Practical Chemistry as applied to the different processes employed in the Arts and Manufactures.

Fees in Guineas—

	Whole Day.			Half Day.	
	6 Days a Week.	3 Days a Week.	2 Days a Week.	6 Days a Week.	3 Days a Week.
Per Session	18	10	7½	12	7
,, Two Terms ..	13	7½	5½	8½	5
,, One Term ..	7	4	3	4½	3
,, Month	3	2	1½		

In order that Students may have an opportunity of acquiring some knowledge of Applied Chemistry, excursions to some of the Mines and Manufactories of the neighbourhood will be occasionally made. They will be conducted by the Professor or by the Lecturer.

Evening Lectures.

Lecturer.—D. Orme Masson, M.A., B.Sc.

Wednesday and Friday, 8 to 9.

This course will consist of Two Lectures a week during the First and Second Terms; they will be devoted to the consideration of the Principles of Chemistry and Chemical Physics and the Study of the chief Non-Metallic Elements. A few Lectures at the end of the Course will be devoted to the consideration of Metals. In treating of the various products under the latter heading special attention will be devoted to their applications in the Arts and Manufactures.

Fee, 10s. 6d. for Two Terms; 7s. for One Term.

Evening Course of Practical Chemistry.

Professor.—W. Ramsay, Ph.D.

Tuesday and Thursday, 7 to 9.

A Practical Class will be formed for instruction in Qualitative and Quantitative Analysis. The Fee for the course (extending over the first and second terms) will be £3 3s., and no additional charge will be made for reagents or apparatus, provided the latter be returned undamaged.

All particulars may be learned by application to the Secretary, University College, Bristol.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.

CHEMICAL DEPARTMENT.

Lectures and Laboratory Instruction are given in Organic, Inorganic, and Analytical Chemistry.

THE YORKSHIRE COLLEGE, LEEDS.

Professor of Chemistry.—T. E. Thorpe, Ph.D., F.R.S., F.C.S.

Lecture Courses.

1. General Course on Inorganic and Organic Chemistry—Monday, Tuesday, Wednesday, and Thursday, at 4 p.m., from October to the end of the second term. Fee for the Course, £4 4s.

2. Lectures on Laboratory Practice and Chemical Calculations—Thursday, at 10 a.m., during the First and Second Terms. Fee, £1 1s.

3. Lectures on the Chemistry of the Non-Metals—Saturday, at 12 a.m., during the First and Second Terms. Fee, 10s. 6d.

Laboratory Courses.

The College Laboratory will be open daily from 9 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it will close at 1 p.m.

Fees for the Session—Students working six days per week, £17 17s.; four, £13 13s.; three £11 11s.; two, £8 8s.; one, £4 4s.

Class in Practical Chemistry, Saturday mornings, from 9 to 12, during First and Second Terms. Fee £1 11s. 6d.

Practical Chemistry for Medical Students.—On Tuesday and Thursday, from 10 to 12 a.m., from May to July.

Evening Classes.

A Course of twenty Lectures by Mr. C. H. Bothamley, on the Elements of Inorganic Chemistry (the Non-Metals) will begin during the first and second Terms, on Fridays, at 8 p.m., beginning October 15. Fee, 10s. 6d.

A Course of Twenty Lectures by Mr. C. H. Bothamley on the Metals will be given during the first and second Terms, on Mondays, at 8 p.m., beginning Oct. 11. Fee, 10s. 6d.

Dyeing Department.

Instructor.—J. J. Hummel, F.C.S.

Lecture Course, with practical work in the Dye-house, for Students who wish to receive, on leaving the College, a certificate of proficiency in Dyeing; such certificate to be obtained by special examination in the several subjects of the Course, the latter extending over a period of two years.

Scholarships.

For Associates.—The Cavendish Scholarship. Value £50 per annum, tenable for one year.

Advanced Scholarships.—

The Brown Scholarship. Value £35, tenable for two years.

The Akroyd Scholarship. Value £30 per annum, tenable for two years.

Entrance Scholarships.—

The Salt Scholarship. Value £20 per annum, tenable for two years.

The Akroyd Scholarships. One, value £25, and one, value £20, tenable for two years.

The Brown Scholarships. One, value £25, and one, value £20, tenable for two years.

The Clothworkers' Company Scholarships. For Textile Department four Scholarships, and for Dyeing Department two Scholarships, each of the value of £25 per annum, and tenable for one year.

UNIVERSITY OF DURHAM. COLLEGE OF PHYSICAL SCIENCE, NEWCASTLE.

Professor of Chemistry.—A. Freire-Marreco, M.A.
Demonstrator—J. T. Dunn, B.Sc.

Junior Division.—General Principles of Chemistry. History of the Non-Metallic Elements. History of the Metals and their more important Native and Artificial Compounds. Principles of Qualitative Analysis. Elements of Organic Chemistry. *Senior Division.*—Organic Chemistry. Elements of Applied Chemistry, including Chemical Mineralogy and Analysis.

Practical Chemistry.—The Laboratory is open from 10 a.m. to 1 p.m., and from 2 to 5 p.m., except on Saturdays, when it closes at 1 p.m. *Laboratory Fees.*—Students working six days per week, £5 5s. per term; alternate days, £3 3s.; one day per week, £1 1s.

Arrangements for Laboratory work in the evening and during vacation will be made.

The Session will commence on October 4.

Courses of Study.—Students will be distinguished into Regular and Occasional. Regular Students will be required to follow such a course of study in the subjects professed in the College as will enable them to pass the Examinations for the title of Associate in Physical Science. Occasional Students will attend such classes as they may select. Every candidate for admission as a regular student must pass an examination on entrance, in reading, writing from dictation, English or Latin Grammar, arithmetic (including decimals), and geography. Registered students in medicine are exempted from this examination, or students who produce a certificate of having passed either of the two following examinations:—

1. Durham Senior Examination of Persons not Members of the University, held in June.

2. Durham Examination for Students in Arts in their first year, or any examination of a similar nature that may be accepted by the Council.

Associateship in Physical Science.—Every candidate for the Associateship in Physical Science, will be required to satisfy the examiners in three, at least, of the four subjects,—Mathematics, Physics, Chemistry, and Geology,—in an examination, to be held at the beginning of his second year.

The examination in Chemistry comprises:—General Principles of Chemistry. Elements of Inorganic Chemistry. Elements of Qualitative Analysis, including a Practical Examination.

The examination in Chemistry for Candidates at the end of their second year comprises:—Elements of Organic Chemistry. Applied Chemistry. Advanced Qualitative Analysis, including a Practical Examination. Elements of Quantitative Analysis.

Exhibitions.—Three Exhibitions of £15 each will be awarded in October next, to Candidates desirous of attending the first year course of study in the College.

Candidates must pass the entrance examination, and will, in addition, be examined in the following subjects:—Algebra, up to Quadratic Equations. Euclid, Books I., II., and III. And one of the following special subjects, to be selected by the Candidate:—Geology.—Text Book: Page's "Introductory Text Book." Heat.—Text Book: "Orme on Heat." Chemistry.—Text Book: Gill's "Chemistry for Schools," omitting chapters xiii., xvi., xx., and xxi. Natural History.—Text Book: Nicholson's "Elementary Text Book of Zoology," or Oliver's "Elementary Botany," Part I.

Candidates must send their names to the Secretary, on or before the 25th of September, and specify, at the same time, the special subject in which they desire to be examined.

The examination will be held at the College, and will commence on Monday, the 4th October.

Two similar Exhibitions will be awarded at the next examination of "Persons not members of the University," which will be held at Durham, and elsewhere, in June next, to those candidates who shall most distinguish themselves in subjects allied to Physical Science.

Scholarships.

T. Y. Hall Scholarship.—This Scholarship, of the yearly value of £20, tenable for three years by students attending two or more of the classes, will be awarded on the result of the first examination for the Associateship in Science.

Charles Mather Scholarship.—This Scholarship, of the yearly value of about £40, will be awarded on the result of the Final Examination for the Associateship in Science, and is tenable for one year from the time of obtaining the Associateship in Science, provided the Scholar continues his studies in the College to the satisfaction of the Professors.

Nathaniel Clark Scholarship.—This Scholarship, of the value of £15 for one year, will be awarded in October to that student who shall pass the First Examination for the Associateship in Science, and who shall be most distinguished in Chemistry and Geology. The Scholar will be required to attend the classes of Chemistry and Geology, so as to be qualified to take those subjects for the Final Examination for the Associateship in June next.

OWENS COLLEGE, MANCHESTER.

Professor and Director of the Chemical and Metallurgical Laboratories.—H. E. Roscoe, B.A., Ph.D., F.R.S., F.C.S.

Professor of Organic Chemistry.—C. Schorlemmer, F.R.S.

Demonstrators and Assistant Lecturers.—Mr. W. C. Williams, F.C.S., P. P. Bedson, D.Sc., and Watson Smith, F.C.S.

Lecture Courses.

Systematic Chemistry.—Junior Class.—Tuesday, Thursday, and Saturday, from 9.30 to 10.30 a.m., during Michaelmas and Lent Terms. Comprising—(1) The laws of Chemical Combination; (2) a description of the physical and chemical properties and the mode of preparation of the Non-Metallic Elements and of their Compounds.

Senior Class.—Monday, Wednesday, and Friday, from 9.30 to 10.30 a.m., during the Michaelmas and Lent Terms, comprising—(1) The Chemistry of the Metals and of their most important Compounds; (2) Organic Chemistry.

The instruction in Systematic Chemistry is given by means (*a*) of Experimental Lectures and (*b*) of Tutorial Classes.

Fee—For each Class, £2 12s. 6d.; for both Classes, £4 14s. 6d.

A Tutorial Class, meeting in Sections, will also be held, which all members of the Junior and Senior Classes will be required to attend, unless specially exempted by the Principal and the Professor. Extra fee for this Class, 10s. 6d. This fee is not included in the composition fees payable by regular Students.

Organic Chemistry.—Professor C. Schorlemmer, F.R.S., Monday, Wednesday, and Friday, from 10.30 to 11.30 a.m.

General Course (from October to the end of March).—The subject of this course is the Chemistry of the Carbon Compounds, wherein the branch of Organic Chemistry is more fully and completely treated than in the general course in Systematic Chemistry.

Extended Course (from the beginning of April to the end of the Session).—This course is suited to the requirements of students preparing for the B.Sc. examination and for those who have previously attended the general course and wish to become more intimately acquainted with the subject. The course will treat of the History of the Old and New Theories, and of the most recent important discoveries in Organic Chemistry, &c.

Fee for the General Course, £2 12s. 6d.; for the Extended Course, £1 11s. 6d.; for both Courses, £3 10s.

Chemical Philosophy.—Prof. C. Schorlemmer, F.R.S., Saturday, from 9.30 to 10.30 a.m.

Sketch of the History of Chemistry; Development of Modern Chemistry; Chemical Law and Theories; Relation of Chemistry to Physics.

Fee, £1 11s. 6d.

Technological Chemistry.—Watson Smith, F.C.S., Monday, from 2.30 to 3.30 p.m.

I. The Alkali and Sulphuric Acid Manufacture; Bleaching Powder and Liquor; Potassium Chlorate; Carbon Bisulphide.

II. Destructive Distillation of Coal; Gas Manufacture; Distillation of Coal-tar: Ammonia and Ammonium Salts from Gas-liquor.

Fee, £1 11s. 6d., in addition to which the Sessional Fee of 7s. will be required from all who have not paid the usual Admission Fee on entering the College.

Analytical Chemistry.—Mr. W. C. Williams, F.C.S. Thursday, from 10.30 to 11.30 a.m.

This Course will treat of the methods of Qualitative and Quantitative Analysis, and is intended to supplement the instruction in Practical Chemistry.

Fee, £1 11s. 6d.

Analytical and Practical Chemistry.

LABORATORY COURSES.

The Chemical Laboratories will be open for Students daily from 9.30 a.m. until 4.30 p.m., except on Saturdays, when they will be closed at 12.30 p.m.

Fees for the Session—For six days per week, £21; for four days per week, £17 17s.; for three days per week, £13 13s. Students entering the Laboratory Class at or after Christmas will be charged two-thirds of the fees for the whole Session.

Fees for shorter periods—For six months, £17 17s.; for five months, £15 15s.; for four months, £13 13s.; for three months, £10 10s.; for two months, £7 7s.; for one month, £4 4s. Students entering under this scale are entitled to work on every day during the week.

The Metallurgical Laboratory will be open daily during the same hours as those of the Chemical Laboratories, for instruction in Practical Assaying and the examination of Ores and Metallurgical products.

Fees the same as those for the Chemical Laboratory Course.

A Course of Lectures on Metallurgy will probably be given in the course of the session if a sufficient number of students offer themselves.

Entrance Exhibitions.

I. Victoria Exhibition (Classics), £15.

II. Wellington Exhibition (Greek Testament), £15.

III. Dalton Mathematical Exhibition, £15. Renewable for a second year.

IV. Grammar School Scholarship, £17 per annum, tenable for three years; open to scholars of the Manchester Grammar School only.

V. Two Oxford and Two Cambridge Local Exhibitions, giving free admission to lecture classes in the College for one year, and renewable for two years further, are awarded annually on the results of the Oxford and Cambridge Examinations held in Manchester in December, 1880, and June, 1881.

VI. Gilchrist Scholarship, £50 per annum, tenable for three years; awarded on the results of the Matriculation Examination of the University of London, in June, 1881.

VII. Rumney Scholarship, £45 per annum, tenable for three years.

VIII. Ramsbottom Scholarship, £40 per annum, tenable for two years. The next competition will take place in 1882.

IX. Crace-Calvert Scholarship, £25 per annum, tenable for two years. The next competition will take place in June, 1882. This scholarship is open only to duly qualified members of the Evening Chemistry Classes.

Fellowship.

The Langton Fellowship, £150 per annum, tenable for three years. Candidates must have been students in the College for not less than three sessions, and must during their studentship or within one year after the close of the same have obtained a degree of some University of the United Kingdom, or been elected to the Associateship of the College. The next competition for the Fellowship will take place in 1881.

Scholarships.

The following (except the Shakspere Scholarship) are open to the competition of students of the College only.

I. Victoria Scholarship (Classics), £40 per annum, tenable for two years.

II. Wellington Scholarship (Greek Testament), £20 per annum, tenable for two years.

III. Shuttleworth Scholarship (Political Economy), £50, tenable for one year.

IV. Shakspere Scholarship (English Language and Literature), £40 per annum, tenable for two years.

V. Bradford History Scholarship, £45 per annum, tenable for one year, and renewable for a second year.

VI. Dalton Chemical Scholarships, two, each of £50 per annum, tenable for two years.

VII. Dalton Mathematical Scholarships, one Senior and one Junior Scholarship, of the value of £25 each, tenable for one year.

VIII. Platt Scholarships (Physiology), two, one offered annually, £50 per annum, tenable for two years. (Two Platt Physiological Exhibitions of £20 each are offered for competition at the end of the Session 1880-1, open to first and second years' students in Physiology.)

IX. Heginbottom Physical Scholarship, £30 per annum, tenable for two years.

X. Ashbury Scholarships (Engineering), two, each of £25 per annum, tenable for two years.

Prizes.

I. Lee Greek Testament Prizes, one of £25 and one of £12 10s. value.

II. Classical Prizes.—Essay, value £5. Junior Class Prizes, value £5 and £2 10s.

III. Shuttleworth History Prize, value £5.

IV. English Essay and Poem Prizes, each of the value of £5.

V. Early English Text Society's Prizes.—A selection of the Society's publications offered to the competition of students in the Day and in the Evening Classes respectively.

VI. New Shakspere Society's Book Prizes.

VII. Cobden Club Book Prizes (Political Economy).

VIII. Dalton Natural History Prize, value £15.

IX. Engineering Essay Prize, value £5.

FIRTH COLLEGE, SHEFFIELD.

Professor of Chemistry and Experimental Physics.—T. Carnelley, D.Sc.

First Year's Course.—Inorganic Chemistry, including Laws of Chemical Combination, Non-Metallic Elementary Bodies, &c. Tuesday, Thursday, Saturday, from 9 to 10 a.m. Fee, £3 13s. 6d.

Second Year's Course.—Inorganic and Organic Chemistry, including Properties of Metals and their Compounds, and the Chemistry of the Carbon Compounds. Monday, Wednesday, Friday, from 9 to 10 a.m. Fee, £3 13s. 6d.

Laboratory.—Working hours to be arranged between Professor and Students. Students proposing to work si days a week can be entered for periods of one, two, o three months on payment of a certain proportion of the Sessional Fees, which are—For six days a week, £18 18s.; four, £14 14s.; three, £10 10s.; two, £7 10s. 6d.; one, £4 4s. Fees for short periods:—For one month, £3 13s. 6d.; two months, £6 6s.; three, £9 9s.; four, £12 1s. 6d.; five, £14 3s. 6d.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

Professor of Chemistry.—T. S. Humpidge, B.Sc.(Lond.), Ph.D., F.C.S.

Lecture Courses.

1. Introductory and Chemistry of the Non-Metals. Monday, Tuesday, Wednesday, and Friday, at 12 noon. From September 15 to January. Fee for the Course, £1.

2. Chemistry of the Metals, on the same days from January to June. Fee for the Course, £2.

3. Organic Chemistry. A Course of 40 Lectures adapted for the Second B.Sc. Examination (London), and other similar examinations. Fee, £1.

Laboratory Courses.

The Chemical Laboratory will be open daily (except Saturdays) for practical laboratory work from 2 to 6 p.m., and at other times on making special application to the Professor. Fee to Students taking Lecture Courses, 15s.

Practical Chemistry for Medical Students.—On Wednesday and Friday, from 3 to 6 p.m., from January to June. Fee to Students taking Lecture Courses, 10s.

ROYAL COLLEGE OF SCIENCE FOR IRELAND, Stephen's Green, Dublin.

Professor of Practical and Theoretical Chemistry.—W. Noel Hartley, F.C.S.

The Chemical and Metallurgical Laboratories, under the direction of Mr. Hartley, are open every week-day

during the Session, except Saturday. Instruction is given in the different branches of Analytical Chemistry, including Assaying, and in the methods for performing Chemical Research. Fee, for the Session of nine months, £12; or for three months, £5; or for one month, £2.

There are four Royal Scholarships of the value of £50 each yearly, with Free Education, including Laboratory Instruction, tenable for two years; two become vacant each year; they are given to Students who have been a year in the College. There are also nine Exhibitions attached to the College, of the yearly value of £50 each, with Free Education, including Laboratory Instruction. tenable for three years; three become vacant each year.

A Diploma of Associate of the College is granted at the end of the three years' course.

ANDERSON'S COLLEGE, GLASGOW.

Professor of Chemistry.—William Dittmar, F.R.S.E.
Chief Assistant.—M. T. Buchanan.
Lecture Assistant.—John Lennox.
Junior Assistants.—R. N. Lennox, James M. Bowie, and John McArthur.

A Course of 100 Experimental Lectures on Chemistry: Daily, Saturdays excepted, from 10 to 11, commencing about the end of October. The Lectures up to the end of the year are devoted to the elements of Chemical Philosophy and to the Chemistry of the Non-metallic Elements. After the new year the Course divides into two branches, viz., the Chemistry of the Metals (on the Mondays and Tuesdays) and Organic Chemistry, select chapters (on the Wednesdays, Thursdays, and Fridays). Six written examinations are held during the Session, which all the members of the class are required to attend.

Fee, £2 2s.

The Laboratory for Practical Instruction in all branches of analysis, including technical assaying, and for original research is open daily (Saturdays excepted) during the Winter Session from 10 to 5, during Summer from 9.30 to 5. Advanced students may obtain permission to work privately on Saturday also until 11 p.m. The teaching is conducted on the tutorial system, each student working by himself and on his own subject. The Laboratory is furnished with all the necessaries for chemical investigation.

Fee for the Winter Session, £10 10s.; Summer Session, £6 6s.; two sessions, if paid in advance, £15 15s., or £2 2s. per month.

Evening Classes.

Lectures on Industrial Chemistry, by Professor W. Dittmar, F.R.S.E., on Friday Evenings, commencing in October. Fee, 2s. 6d.

The following two courses have have been instituted specially for students preparing for the examinations held by the Government Department of Science and Art:—(1) A preparatory course of Scientific and Practical Chemistry. Mondays, 7.30 to 10. Fee, £1 1s. (2) A similar course for more advanced students. Wednesdays, 7.30 to 10. Fee, £2 2s.

THE

"YOUNG" CHAIR OF TECHNICAL CHEMISTRY, ANDERSON'S COLLEGE.

Professor.—Edmund J. Mills, D.Sc. (Lond.), F.R.S.
Senior Assistant.—Mr. J. Snodgrass.
Junior Assistant.—Mr. J. Bicket.

This Chair has for its object the instruction of Students in Chemistry as applied to the various branches of industry in Chemical and other works, Metallurgy, Agriculture, &c.

Lectures.—*Principal Course.*—A Course of Fifty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m., commencing on November 1st. The Lectures will be illustrated with Experiments, Diagrams, and Models, as well as by the actual Inspection of Manufacturing Processes; and the progress of the Students will be tested by periodical Examinations. The earlier Lectures will have reference to units of weight and measure, to the calculations necessitated by Chemical operations, and to the nature and laws both of the Chemical process and its results. A particular subject will then be considered in comparatively minute detail, embracing for this session Oils, Paints, and Varnishes. These lectures are intended to qualify for the examination of the City and Guilds of London Institute for the Advancement of Technical Education.

Fee for the Course, Two Guineas. To Laboratory Students, One Guinea.

Subsidiary Course.—A subsequent Course of Thirty Lectures will be delivered on Mondays, Tuesdays, and Wednesdays, at 10 a.m. These Lectures are more particularly intended for Dyers, Colour Manufacturers, Brewers and Distillers, Tar Rectifiers, Drysalters, and others interested in a knowledge of Technical *Organic* Chemistry.

Fee for the Course, Two Guineas.

Technical Physical Chemistry.—Mr. J. Snodgrass, Senior Assistant, has arranged to deliver a series of Thirty Lectures and Demonstrations on Physico-Chemical Measurements.

Fee for the Course, Half-a-Guinea. Laboratory Students, Half-a-crown.

Laboratories.—The Laboratories are open daily from 10 to 4, and on Saturday from 10 to 1 o'clock for practical working by the Students, under the superintendence of the Professor and his Assistants.

The Fee for attending the Laboratories is £20 per Session of Nine Months, £14 10s. for Six Months, £7 10s. for Three Months, or £2 10s. per month.

Students must have a fair acquaintance with elementary Chemistry.

The New Laboratory Buildings, immediately contiguous to the former site, are now erected and occupied. They comprise four stories, with a lecture room in the rear, and are exclusively devoted to the purposes of this Chair.

The Trustees, having had under consideration the requirements of Inventors, Patentees, and others whose investigations require isolation and privacy, as well as professional advice, have included in the arrangements Five Private Laboratories, which will, it is expected, meet a demand hitherto unsupplied in this country.

Library.—A Students' Library Society was founded in 1875. Its objects are to provide a collection of standard chemical works, and to maintain a regular supply of chemical journals. A large number of works have already been purchased or bestowed, and nine journals are received. Annual subscription, Half-a-crown.

Memorandum as to Bursaries.

The Trustees of the "Young" Chair have the superintendence of the Bursaries—regulating the appointment and terms on which they shall continue to be held.

The Nominees of Donors to be appointed if they pass the necessary examinations.

The Bursaries are of the amount of £50 each per annum, tenable for three years, during which the Bursars shall be required to give their whole time and attention to the Lectures and Laboratory duties of the "Young" Chair, paying the ordinary fees. Candidates to have attained sixteen years of age on application, to be of good moral character, and to pass such examinations as may be prescribed by the Trustees in the ordinary branches of an English education and the elementary principles of Chemistry. The Bursaries to be liable to forfeiture on the Bursars failing to exhibit approved progress under the Professor of the Chair, or being guilty of conduct, in the opinion of the Trustees, unworthy of their position. The Bursaries are only given to those whose means are limited, and who intend following some branch of Manufacturing Chemistry.

CHEMICAL LECTURES, CLASSES, AND LABORATORY INSTRUCTION.

City of London College, 52, Leadenhall Street, E.C.—Chemical Lecturer—Thomas Eltoft, F.C.S., F.I.C. The courses of lectures are as follows:—

Elementary Electricity	Mondays,	6.30—7.30.
Elementary Chemistry	,,	7.30—8.30.
Elementary Organic Lectures..	Tuesdays,	6.30—7.30.
Advanced and Elementary Organic Practical Class	,,	7.30—9.0.
Advanced Organic Chemistry, Lectures	,,	9.0 —10.0.
Elementary Inorganic Chemistry, Practical Class	Wednesdays,	8.15—9.45.
Advanced Inorganic Chemistry, Lecture	Thursdays,	7.15—8.15.
Do. Practical Class	,,	8.15—10.0.

The above classes will cover all the work required for Matriculation, College of Surgeons, First B.Sc., Preliminary Scientific, and Second B.Sc. (University of London). The above lectures will also prepare for the South Kensington Examinations. Fees: Lectures for the Session 15s.; Practical Chemistry, 15s. All Students are expected to sit at the May Examination. Lectures commence on Sept. 27th at 7.30, and are continued on every Monday throughout the Session.

Crystal Palace Company's School of Art, Science, and Literature. School of Practical Engineering. *Principal*—Mr. J. W. Wilson, Assoc. Inst. C.E.—This school was established with the purpose of affording to Students of Civil or of Mechanical Engineering the advantage of thorough practical instruction in the rudiments of either profession, and in the manipulation of materials. The leading object is to prepare Students, by systematic practical instruction, for professional articles, so that on entering an Engineer's office or works the pupil may at once be useful to his Principal, and enabled to take advantage of the opportunities for learning open to him, because he has mastered the elementary details of the profession. The school is also available for Students already articled, who desire instruction either in the offices or shops. The Colonial Section is designed particularly for gentlemen who are going to the Colonies or abroad, as explorers or settlers. The object proposed is to afford them so much practical knowledge of scientific and mechanical work and expedients as shall enable them best to utilise the means at their disposal, especially when entirely dependent on their own resources.

Special Courses of Lectures are delivered by independent Lecturers not on the Staff of the School, and are an addendum to the curriculum. These Special Courses include a Course of Six Lectures on the Physiography of the Principal Districts of the World; a Course of Six Lectures on the Chemistry of Manufactures and Mines; and a Course of Six Lectures on the Mechanics of Practical Mining.

Ladies' Division.—The School was established to utilise the valuable Courts and Collections of the Crystal Palace for the purposes of instruction in Art, Science, &c., so that education of the highest class might be afforded on reasonable terms under most advantageous conditions. The system of tuition is, for some subjects, in the manner of private tutorial instruction by the best masters, but other subjects are taught on the University method, in accordance with the regulations laid down by the Syndicate of the University of Cambridge, by whom some of the lectures and classes are conducted. A student may take lessons in one or several studies at option. The School is a centre for both the University of Oxford and the University of Cambridge Local Examinations, the Oxford Examination for Women, and for the Cambridge Higher Local Examination. The following examinations will be holden in the Ladies' Division during 1880-81:—Cambridge Local, December, 1880; Oxford Local and Oxford Examination, for Women, May, 1881; Cambridge Higher Examination, June 1881. The session opens on October 1.

The Courses of Science Lectures during the ensuing term will include one on Physical and one on National Geography, on Mondays, by Prof. H. G. Seeley, F.R.S., and another on Botany, on Weduesdays, by Mr. Henry N. Read, M.A., of St. John's College, Cambridge. Fees: Twelve Lectures and Classes, £1 1s. One Lecture, 1s.

Berners College of Chemistry and the Experimental Sciences, 44, Berners Street, W.—Prof. E. V. Gardner, F.A.S., M.S.A. The Laboratory is open morning and evening throughout the year.

Birkbeck Literary and Scientific Institution, Southampton Buildings, Chancery Lane.—Inorganic Chemistry. Lectures:—Elementary, Tuesdays, 8.30 to 9.30; Advanced, Saturdays, 7 to 8. Practice:—Elementary, Saturdays, 4 to 6; Advanced, Saturdays, 8 to 10. Teacher, Geo. Chaloner, F.C.S. Organic Chemistry:—Course of Thirty Lectures will be given on Tuesday evenings, at 7 o'clock, by Mr. H. Chapman Jones, F.C.S., commencing on October 5th. Practical Organic Chemistry:—This Class will meet in the Laboratory of the Institution, under Mr. Chapman Jones's direction, on Saturdays from 4 to 6 and from 8 to 10 p.m.

New Central School of Chemistry and Pharmacy, 173, Marylebone Road, London.—Mr. A. P. Luff, F.I.C., F.C.S., and Mr. J. Woodland, F.C.S., M.P.S.

Onslow College of Science, 183, Kings Road, Chelsea, S.W.—Special Evening Classes in Inorganic and Organic Chemistry, &c. The Chemical Laboratory is open on Friday Evenings from 8 to 10 p.m. and on Saturday from 2.30 to 10 p.m.

Royal Veterinary College, Camden Town.—Professor of Chemistry, Mr. R. V. Tuson.

School of Pharmacy of the Pharmaceutical Society of Great Britain, 17, Bloomsbury Square.—The school opens on Friday, the 1st of October. Lectures on Chemistry and Pharmacy, by Professor Redwood, on Monday, Tuesday, and Wednesday mornings, at 9 a.m. The Laboratories for Practical Instruction in Chemistry as applied to Pharmacy, &c., under the direction of Prof. Attfield, will be open daily at 10 a.m. throughout the Session. They are fitted up with every convenience for the study of the principles of Chemistry by personal experiment, synthetical as well as analytical. They are specially designed for the student of Pharmacy, but are also well adapted for the acquirements of a knowledge of Chemistry in its application to Medicine, Manufactures, Analysis, or Original Research. There is no general class for simultaneous instruction, each student following an independent course of study always determined by his previous knowledge; pupils can therefore enter for any period at any date. Fees, One Course, £3 3s.; an entire Session—Two Courses, £4 4s.; Perpetual Admission, £5 5s. *Council Prizes.*—At the end of each of the five months' Courses of Lectures on Chemistry and Pharmacy, and Botany and Materia Medica, a Bronze Medal and Certificates of Merit, and at the close of the Session (ten months) a Silver Medal and Certificates of Honour and Merit, are offered for competition by the Council. In the Class of Practical Chemistry, the Silver Medal, two Bronze Medals, and Certificates of Honour and Merit, offered by the Council, are competed for at the end of the Session only.

South London School of Chemistry, 325, Kennington Road.—Dr. John Muter, F.C.S. Daily, at 10 a.m. Sixty Lectures on Theoretical Chemistry, and Junior and Senior Course of Practical Chemistry.

St. Thomas Charterhouse School of Science, Goswell Road, E.C.—Chemical Lecturer—Thomas Eltoft, F.C.S., F.I.C. A course of 40 Lectures on each of the following subjects will be given:—Elementary Inorganic Chemistry, Advanced Inorganic Chemistry, Elementary Organic Chemistry, Advanced Organic Chemistry. After each lecture the student will do practical work. The Chemical Laboratory is capable of accommodating 60

Students. It is thoroughly ventilated, and has been fitted up at a large cost. All apparatus and chemicals are found. The work is so arranged as to prepare students for any examination in chemistry. The Lectures will commence on September 28th, at 6.30 and 9.0 p.m. Lectures are held on Tuesdays, Wednesdays, and Thursdays. Fees: Lectures and Practical Work, 25s. For further particulars apply to the Secretary, Mr. Chas. Smith.

The Westminster College of Chemistry and Pharmacy, Lambeth Road, S.E.—Messrs. Wills and Wootton. Daily, at 9.30 a.m. Theoretical and Practical Chemistry.

CHEMICAL LECTURES AT LONDON HOSPITALS.

Chemical Schools and Colleges.	Winter Session. Lecturers on Chemistry.	Winter Session. Days and Hours.	Winter Session. Fees. One Course.	Winter Session. Fees. Perpetual.	Summer Session. Lecturers on Chemistry.	Summer Session. Days and Hours.	Summer Session. Fees. One Course.	Summer Session. Fees. Perpetual.
			£ s.	£ s.			£ s.	£ s.
St. Bartholomew's Hosp. and College	Dr. Russell, F.R.S.	M. W. F., 9	6 16/6	9 9	Dr. Russell	M. Tu. F., [to 1 11	3 3	3 3
Charing Cross Hospital and College	Mr. Heaton	M. W. Th., 11	5 5		Mr. Heaton	M. W.	4 4	
St. George's Hospital ..	Mr. Donkin	Tu. Th. S., 11½	7 7	8 18	Mr. Donkin	Daily at 10	4 4	
Guy's Hospital	Dr. Debus, F.R.S., and Dr. Stevenson	Tu. Th. S., 11	7 7		Dr. Debus	M. W. F., to 1	7 7	
King's College and Hosp.	Mr. Bloxam, F.C.S., Mr. Thomson, and Mr. Johnson	M. W. Th., 10½	8 8	11 11	Mr. Bloxam and Mr. Thomson & Mr. Johnson	M. W. Th., 10½	6 6	8 8
London Hospital	Dr. Tidy	M. W. F., 10	7 7		Dr. Tidy	M. Th. S., 9	5 5	
St. Mary's Hospital ..	Dr. Wright	M. Th. 10, W. S., 9	6 16/6		Dr. Wright	W. F. S.	4 4	
Middlesex Hospital ..	Mr. W. Foster	M. W. Th. Fr., 3	6 6	8 8	Mr. W. Foster	M. W. F., 3	3 3	
St. Thomas's Hosp. & Schl.	Dr. Bernays	Tu. Th. F., 10	7 7		Dr. Bernays	M. Th. F., 10	6 6	
University Col. & Hosp.	Dr. Williamson, F.R.S.,	Daily (ex. S.) 11	7 7	9 9	Dr. Williamson	Daily (ex. S.) 11	5 5	
Westminster Hospital ..	Dr. Dupré, F.R.S.	W. Th. F., 3	6 6		Dr. A. Dupré	M. W. F., 10	4 4	

Birmingham.—Midland Institute.—Mr. C. J. Woodward, B.Sc. Tuesday and Thursday, at 8 p.m.; Friday, at 7; and Saturday, at 3.

Birmingham.—Queen's College.—Mr. A. Bostock Hill, M.D.

Bristol Medical School.—Mr. T. Coomber, F.C.S.

Liverpool Royal Infirmary School of Medicine.—J. Campbell Brown, D.Sc. Lond., F.C.S.

School of Technical Chemistry, 7 and 9, Hackin's Hey, Liverpool.—Mr. A. Norman Tate.

College of Chemistry, Liverpool—Mr. S. H. Johnson, F.C.S.

Leeds School of Medicine.—Prof. T. E. Thorpe, Ph.D., F.R.S.

Leeds Mechanics' Institution.—Mr. G. Ward, F.C.S.

Manchester Mechanics' Institution.—Mr. W. A. Watts, M.A., and Mr. Yates. Evening Classes.

Queenwood College, near Stockbridge, Hants.—Mr. E. W. Prevost, Ph.D., F.C.S., F.R.S.E.

Salford Working Men's College, Evening Classes.—Teacher of Chemistry, Mr. G. H. Hurst. Lectures on Organic and Inorganic Chemistry and practical laboratory instruction.

Sheffield Borough Analysts' Laboratory, 1 and 3, Surrey Street.—Mr. A. H. Allen, F.C.S. Day and Evening Classes.

Sheffield School of Medicine.—Mr. A. H. Allen, F.C.S. A course of Lectures on Inorganic and Organic Chemistry is delivered by Mr. Alfred H. Allen during the Winter session. The Summer Course of Practical Chemistry is under the direction of Mr. A. H. Allen.

Aberdeen School of Science and Art Mechanics' Institution.—Mr. Thomas Jamieson, F.C.S.

Dundee Literary Institution Chemical and Physical Laboratory.—Lecturer on Chemistry, Mr. Frank W. Young, F.C.S., and Mr. John Thomson.

University of Edinburgh.—Prof. A. Crum Brown, F.R.S.E.

School of Medicine, Edinburgh.—Dr. Stevenson Macadam, F.R.S.E., Mr. Falconer King, Mr. Ivison Macadam, Mr. Drinkwater, and Mr. Buchanan.

School of Pharmacy and Chemistry, Edinburgh.—The instruction qualifies for graduation in Medicine and Science in the University of Edinburgh and other Examining Boards. Chemistry, Mr. Drinkwater, F.C.S., L.R.C.P.; Materia Medica and Pharmacy, Dr. Urquhart; Botany, Mr. D. M'Alpine, B.Sc. Lond. Day and Evening Classes.

Minto House Medical School, Chambers Street, Edinburgh.—Lectures and Classes.

Glasgow University.—Prof. J. Ferguson.

Glasgow Mechanics' Institution.—Mr. R. R. Tatlock, F.R.S.E., F.C.S.

Glasgow Veterinary College.—Mr. Stephen Cooke, F.C.S.

School of Chemistry, 138, Bath Street, Glasgow.—Dr. Wallace, Mr. Tatlock, and Dr. Clark. Day and Evening Classes.

Chemical Laboratory, 144, West Regent Street, Glasgow.—Dr. Milne. Day and Evening Classes.

Analytical Laboratory, 88, Hope Street, Glasgow.—Dr. A. T. Machattie, F.C.S. Day and Evening Classes.

Queen's College, Belfast.—Dr. Letts.

Queen's College, Cork.—Dr. Maxwell Simpson.

Queen's College, Galway.—Dr. T. H. Rowney.

Royal College of Surgeons in Ireland.—Dr. C. A. Cameron.

Dublin, Carmichael School.—Dr. C. R. C. Tichborne.

Dublin, Catholic University.—Mr. Campbell.

Dublin, Dr. Steevens's Hospital and Medical College.—Mr. McHugh.

Pyridic Bases.—M. Oechsner de Coninck.—On the distillation of cinchonine with 3 parts of caustic potassa the author obtains a lutidine, a collidine, and a parvoline, all of them novel.—*Comptes Rendus.*

ACTION OF LIGHT UPON THE SOLUBLE IODIDES,

WITH THE OUTLINES OF A NEW METHOD IN ACTINOMETRY.*

By Dr. A. R. LEEDS.

In the June number of the *Philosophical Magazine* for 1879 I published an article with the above title, and gave an abstract of three preceding papers dealing with various parts of the same subject, viz. :—"Upon the Titration of Hydrochloric Acid for Chlorine, and of Sulphuric and Nitric Acids for Hyponitric Acid" (1st and 2nd papers, *Proc. Am. Chem. Soc.*, vol. ii., 1878, and *Jour. Am. Chem. Soc.*, vol. i., 1879); also, "Upon the Influence of Light upon the Decomposition of Iodides" (*Jour. Am. Chem. Soc.*, vol. i., 1879). In the first of these papers I gave an account of the anomalous reaction which first attracted my attention to the subject, and led me to undertake a series of laborious quantitative determinations extended over an interval of three months. This was, that on titrating very dilute solutions of the acids with potassium iodide (1 c.c. acid to 1000 c.c. water) no change occurred immediately, but at the end of twelve hours an amount of iodine had been set free corresponding to 0·42 c.c. of a standard sodic hyposulphite solution in the case of the hydrochloric acid, to 0·28 c.c. with the sulphuric acid, and to 0·24 c.c. with the nitric acid. After decolorisation with the hyposulphite slow change again set in, and a series of titrations—beginning with October 27th, 1878, and extended to December 5th, 1878, eleven in all—was given, showing that a constant source of change was operating upon the mixtures of very dilute acids and iodide, the summations of the changes effected during the interval being, for the hydrochloric acid 1·23 c.c., for the sulphuric acid 5·17 c.c., and for the nitric acid 2·41 c.c. This source of constant change was thought to be the diffused light of the laboratory, and in the second paper the results of testing this hypothesis under a great variety of conditions and with many precautions as to purity of acids, iodides, &c., were detailed at length. In the third paper the various phenomena noted are brought into reconciliation by recognising that *oxygen was essential to the reaction*, no change whatsoever occurring either in the dark or in the strongest sunlight during several days' exposure, in case the presence of oxygen were rigorously excluded. This observation likewise explained the real difficulty at the root of the acrimonius controversy between Schönbein and Fischer, Houzeau, and Sauvage,† as to whether or no perfectly pure potassium iodide in dilute solution is decomposed by free sulphuric acid.‡ The answer to this question, as determined by the author from the experiments quoted, was that either in light or darkness free acid will decompose potassium iodide, if oxygen is present, even when the dilution is carried to the one-four-thousandth part; but in case oxygen is absent, solutions of potassium iodide with excess of free acid, and both solutions of considerable strength, may be kept for days in the dark or in strong sunlight without a liberation of iodine.

Furthermore, all the cases of soluble iodides experimented upon, and the acids—organic acids as well—were shown to undergo a change represented by the equation—

$$4MI+4HA+O_2=4MA+2H_2O+2I_2,$$

where M indicates the monovalent basic, and A the monobasic acid radical.

In the earlier experiments (2nd paper), before the indispensable co-operation of oxygen in the decomposition of the iodides in presence of free acid had been recognised, the law of change of the iodides in the dark appeared to be quite different from that operating when they were exposed to the light. In the former case the amount of decomposition of the iodide was approximately proportional to the degree of concentration; in the latter, the reverse appeared to be true. This curious anomaly was done away with by the next step in the investigation; for in the preliminary trials bottles of different forms and material had been used in holding the solutions. But it was evident that not only would the varieties in shape greatly alter the relative surfaces of exposure to the solar ray, but differences in tint of the glass—yellowish, white, pink, &c.—strongly affect the percentage of the transmitted actinic component of the beam. For these reasons, comparison-tubes of uniform bore and dimensions (25 c.m. in length, 3 c.m. in diameter), such as the author has proposed in his colour comparator,* all made of the same thin perfectly colourless glass, were substituted. The anomalies now disappeared.

Before proceeding further, however, it was essential to determine to what extent the pure acids themselves underwent decomposition in the sunlight, and to this end 50 c.c. of nitric acid of sp. gr. 1·4, 50 c.c. of sulphuric acid of sp. gr. 1·84, and 50 c.c. of hydrochloric acid of sp. gr. 1·202, were hermetically sealed in bottles, and exposed at a south window from Dec. 10th, 1878, to Jan. 21st, 1879. "At the end of this period 1 c.c. of each was taken, diluted with 1 litre water, potassium iodide and starch-water added, and allowed to stand for twenty-four hours in darkness." They gave on titration—

1 c.c. HNO_3 = 14·80 c.c. $Na_2S_2O_3$
" H_2SO_4 = none
" HCl = none

This experiment was the first of a series which are given at length in the articles referred to, by which it was shown that the decomposition of soluble iodides in the presence of light and of free nitric acid, does not confirm to the same general law which operates in the case of acids not of themselves decomposable by sunlight: the equations which explain the different deportment of nitric acid were given in full, and the necessity of rejecting its employment in making actinometric measurements was emphatically pointed out.

"This investigation suggested a convenient method for studying the variations in the actinic force of the solar ray, which was to determine the amount of iodine set free by its action under identical conditions. In the following experiments, the first which were instituted in this direction, no attempt was made to determine absolute values. A series of comparison-tubes, each containing 1 c.c. H_2SO_4, 1 c.c. KI, and 5 c.c. starch-water, with the amounts of water specified, were exposed at times and during intervals given, upon a comparator, the frame of which was kept normal to the solar ray."

RELATIVE ACTION OF THE SUN'S RAYS (JAN. 22, 1879).

	20 c.c. H_2O. M.grm. I.	60 c.c. H_2O. M.grm.	100 c.c. H_2O. M.grm.
9 — 9·30 a.m.	0·24	0·27	0·38
9.30—10	0·22	0·29	0·37
10 —10.30	0·24	0·40	0·40
10.30—11	0·39	0·76	0·71
11 —11.30	0·67	1·25	1·29
11·30—12	0·67	1·25	1·46
12 —12.30 p.m.	0·55	1·25	1·54
12.30—1	0·60	1·50	1·73
1 —1·30	0·50	1·13	1·31
1·30—2	0·40 (clouded over)	0·75	0·92

* Dr. Leeds's letter announcing the dispatch of the MS. of this article, was dated June 10, 1880, and was duly delivered in about twelve days from that time. The MS. itself was, however, delayed in the post, and after an extra double journey across the Atlantic, only arrived the first week in July. Further time has been consumed, owing to the necessity of sending a proof to the author.—*Ed.* C.N.

† *Jour. fur Prakt. Chem.*, 1845, xxxiv., p. 492, and *Comptes Rendus*, 1868, lxvii., pp. 663, 714, 1138.

‡ See, also, Fischer, *Pogg. Ann.*, lxvi., p. 168; *Jour. Prakt. Chem.*, xxxiv., p. 186. Also, Dulk, *Jour. Prakt. Chem.*, xxxiv., p. 344, criticism on Schœnbein's paper, "Some Notes upon Potassium Iodide."

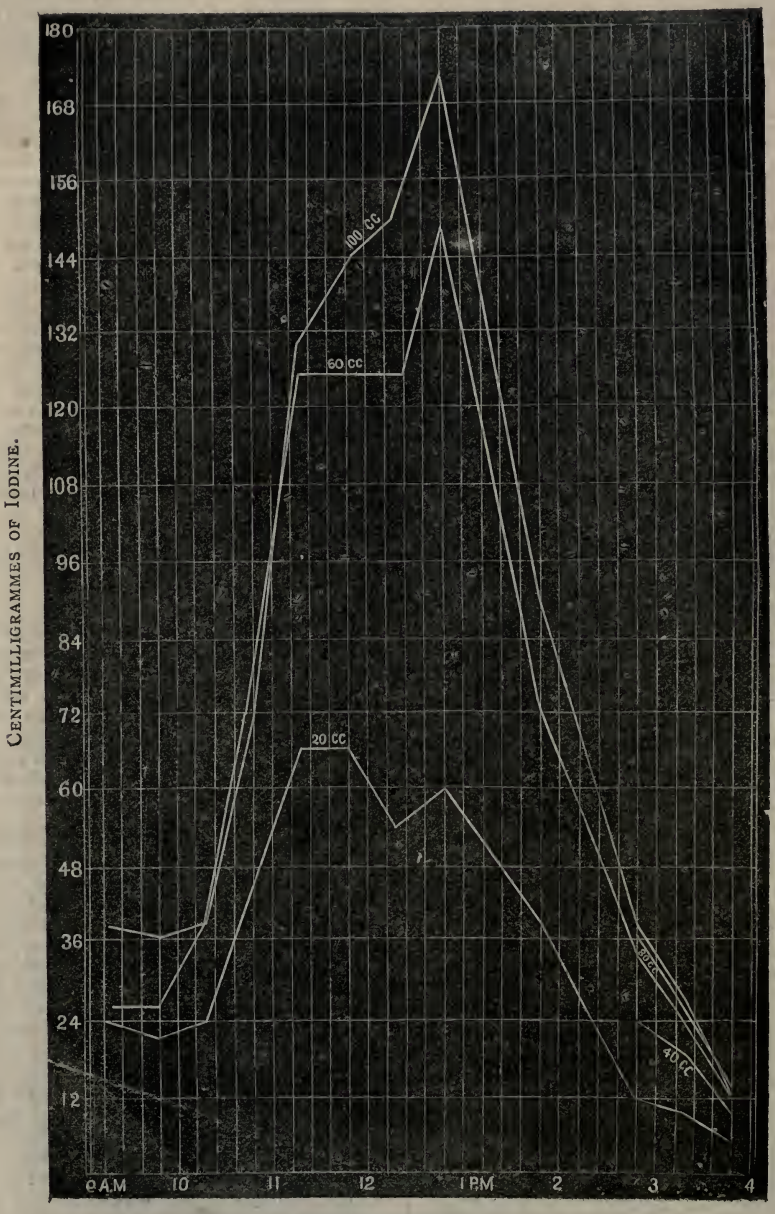
* CHEMICAL NEWS, vol. xxxvii., p. 229.

Continued (Jan. 24).

	20 c.c. H_2O.	40 c.c. H_2O.	60 c.c. H_2O.	80 c.c. H_2O.	100 c.c. H_2O.
2.30—3	0·125	0·24	0·33	0·38	0·40
3 —3·30	0·11	0·18	0·24	0·27	0·28
3·30—4	0·07	0·10	0·12	0·13	0·12

hydrogen method of Draper, which received at the hands of Bunsen and Roscoe the various instrumental refinements essential to accurate quantitative results, requires a corresponding complexity of apparatus and nicety of manipulation, and is therefore carried into execution with difficulty by the working chemist. The method just described needs little or no apparatus beyond that essential to any well-equipped laboratory."

Fig. I.



"It will be seen on inspection of the accompanying diagram that the curve representing the amount of iodine set free in the 40 c.c. solution and the 80 c.c. solution was intermediate between the curves of 20 and 60, and 60 and 100 respectively. Moreover, the determination of the liberated iodine is so easily made that we possess in this method a convenient form of actinometry, lending itself readily to various practical applications. The chlorine-

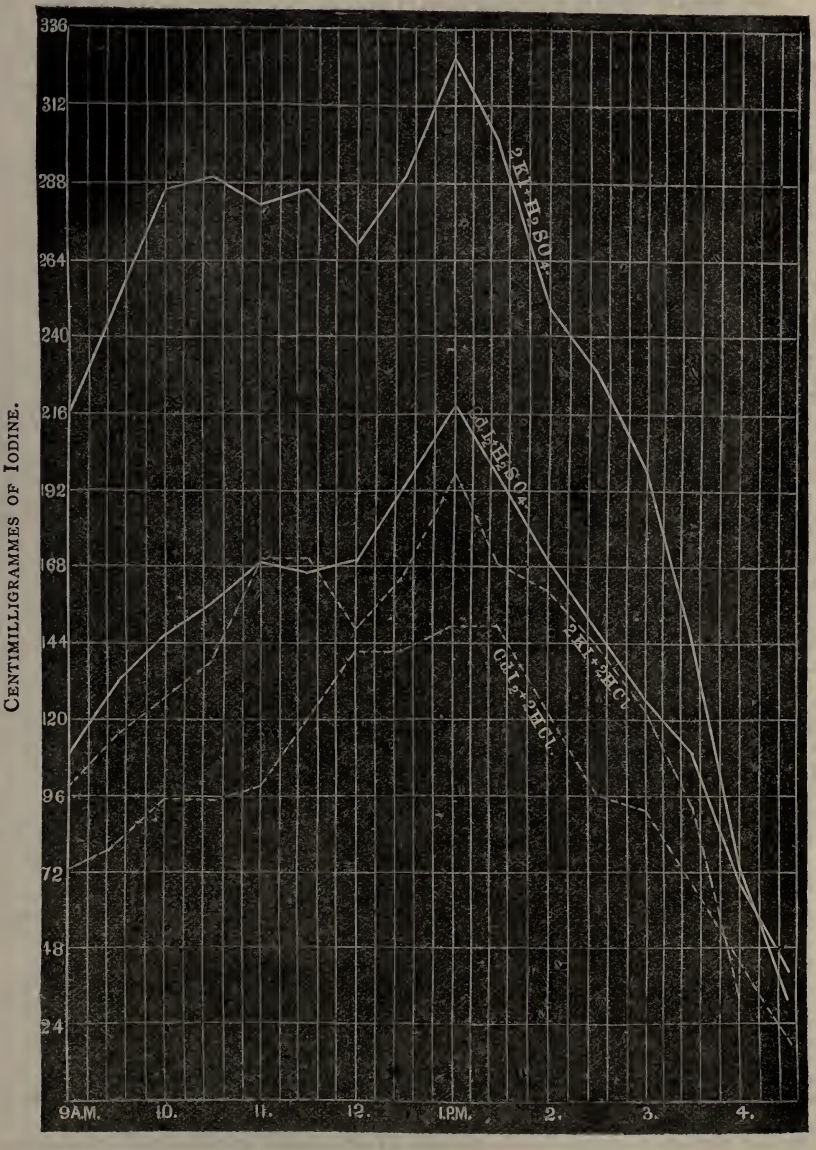
The next question investigated (3rd paper) was—"*To determine whether a change of base influenced the rate of decomposition in the sunlight, when the same acid was employed; or with the same base when different acids were used.*"

In solving this question, the intention was to employ

Actinometric Determination, February 27, 1879.

Reagents.	A.M. 9 to 9.30.	9.30 to 10.	10 to 10.30.	10.30 to 11.	11 to 11.30.	11.30 to 12.	12 to 12.30.	P.M. 12.30 to 1.	1 to 1.30.	1.30 to 2.	2 to 2.30.	2.30 to 3.	3 to 3.30.	3.30 to 4.	4 to 4.30.	4.30 to 5.	Mns
1 c.c. H_2SO_4+1 c.c. KI ..	215	250	285	290	280	285	270	290	325	300	250	225	200	155	75	35	233
„ HCl „ „ ..	100	115	125	140	170	170	155	165	200	170	160	145	125	90	35	23	131
1 c.c. H_2SO_4+1 c.c. CdI_2	115	130	145	155	170	165	170	195	220	195	170	150	130	110	70	43	146
„ HCl „ „	75	85	100	100	105	120	140	140	150	150	120	95	90	65	35	20	99
1 c.c. H_2SO_4+1 c.c. LiI ..	120	130	135	145	160	150	160	170	155	145	150	140	125	105	65	43	131
„ HCl „ „ ..	75	80	95	100	100	100	110	120	120	110	100	75	70	50	30	18	84
1 c.c. H_2SO_4+1 c.c. NH_4I	130	140	155	165	180	170	180	190	195	180	170	150	120	105	70	45	146
„ HCl „ „	85	95	100	100	115	115	115	120	115	115	110	85	90	60	30	18	92

Fig. II.



February 27, 1879. Half-hours.

chemically equivalent solutions of the acids, but by an error in the calculations the solutions actually employed in this and the subsequent parts of the work were of such strength that 1 c.c. of the sulphuric acid corresponded to 0·43 c.c. of the hydrochloric and to 0·504 c.c. of the nitric acid. The experiments were made and the woodcuts

executed before the error was discovered, which accounts for the publication of the results as given in the articles alluded to, and from which only I shall quote in the present communication. But whilst I was unable at that time to undergo the expense of having new plates made, and published these somewhat imperfect results just as they stood, I repeated, in March, 1879, the experiments with truly equivalent solutions, and shall in a subsequent paper make them known, with appropriate graphic representations.

In all the earlier trials starch-water was used in making up the solutions in the comparison-tubes to the desired volume, since "*the supposition had been that its affinity for the liberated iodine, though feeble, had nevertheless been one of the agencies at work in determining the fact of a decomposition.*" But a series of trials is given (3rd paper) with the iodides of potassium, cadmium, and lithium, and with the three mineral acids, which showed that in every instance the amount of decomposition was greater when the addition of starch was omitted. The dense precipitate of starch iodide suspended in the tubes cut off to a large degree the action of the light upon the solutions. Moreover, the disturbing effect of such an opaque precipitate was so great that the striking quantitative relationships existing between the amounts of iodine liberated by the unequal chemism of different acid radicals for the same metallic base were not made manifest, until by doing away with the starch the reactions were rendered normal. The most important instance of this constant difference of chemism which as yet has been worked out is that between $\frac{1}{2}H_2SO_4$ and Cl in the presence of KI, CdI_2, NH_4I, and LiI solutions exposed to sunlight.

The progress which had been made in solving the question above italicised will be gathered from an examination of § VII. (3rd paper), "Upon the Actinometric Determination of Sunlight," which begins by stating that—"In order to compare the decomposition effected by the sunlight, after passing through various thicknesses of the earth's atmosphere, and the relative amounts of iodine set free under these circumstances, when different salts were employed, the determinations summarised in the accompanying table (p.149) were made. The day was unusually brilliant and unclouded, from beginning to close. The amounts of iodine are given in centimilligrms. The solutions were all made up to 100 c.c.

Unfortunately, as before stated, the solutions were not chemically equivalent, 1 c.c. of the H_2SO_4 corresponding to 0·43 c.c. HCl, and the potassium iodide solution being of 20 per cent, the other iodides of 10 per cent. But if we multiply the means of the number of centi-milligrms. of iodine, in each case set free in the presence of the sulphuric acid, by 0·43 (the number expressing the relative strength of the hydrochloric acid), and divide the products into the amounts of iodine liberated by the hydrochloric acid, we obtain the following ratios :—

$H_2SO_4 + KI = 233 \times 0{\cdot}43 = 100$
HCl ,, $= 131 \times 1 = 131$, or 1 : 1·31
$H_2SO_4 + CdI_2 = 146 \times 0{\cdot}43 = 64$
HCl ,, $= 99 \times 1 = 99$, or 1 : 1·55
$H_2SO_4 + LiI = 131 \times 0{\cdot}43 = 56$
HCl ,, $= 84 \times 1 = 84$, or 1 : 1·50
$H_2SO_4 + NH_4I = 146 \times 0{\cdot}43 = 63$
HCl ,, $= 92 \times 1 = 92$, or 1 : 1·46
Mean ratio for 128 experiments, = 1 : 1·45

We have here a set of ratios obtained with 128 solutions exposed during the course of one day, under identical circumstances in each corresponding experiment of time of exposure, temperature, surface, intensity and quantity of light, size and nature of vessels, &c. The ratio 1 : 1·31, obtained with the potassium iodide solution, is retained, though it might without violence be thrown out, inasmuch as this solution contained 20 per cent of the iodide, the other three but 10 per cent of their respective iodides. We have reason, therefore, for bringing forward the hypothesis that the chemism of the Cl radical as compared with that of the $\frac{1}{2}SO_4$ radical, and as made manifest by the amount of metathetical decomposition taking place in sunlight in mixtures of their hydrogen salts with the iodides of certain metallic radicals, may be expressed by a certain ratio; and without claiming anything further than the suggestion of some quantitative relationship not as yet fully apprehended, this ratio might be expressed as a law of specific actinic forces under the formula :—

The chemism of the chlorine radical is to that of the $\frac{1}{2}SO_4$ radical (measured by the relative amounts of iodine liberated by each respectively in solutions of the metallic iodides exposed to sunlight), as 1·45 : 1. This formula holds good, as was shown in the unpublished actinometric determinations made March 26, 1879, for rigorously chemically equivalent solutions of the acids. But the ratio requires change when the actinic power emanates from a different source,—the magnesium lamp, for example. This will be forcibly shown farther on. A similar law appears to be true of the amounts of iodine set free from iodides of different metals, when exposed to the action of sunlight in presence of the same acid, these amounts standing in definite ratios one to another.

Before leaving this diagram, I wish to point out the remarkable depression in the $2KI + H_2SO_4$ curve and the $CdI_2 + H_2SO_4$ curve between the hours of 11 a.m. and 1 p.m. As soon as this tendency was noted I naturally anticipated the passage of some visible mist or haze across the sun. Such, however, was not the case, the sky appearing just as brilliant and blue during this interval as before and after. I deemed it not improbable that this absorption of the actinic component of the solar ray was due to the passage of some mass of aqueous vapour, or some other alteration in the physical or chemical constitution of an interjected atmospheric layer, which, though invisible to the sense of sight directly, had been written down in the sensitive chemical fluid by the blurred tracing of the actinic rays. This, indeed, was an animating thought—that we possess in the undulations of the solar beam, which are too rapid to affect vision, a delicate probe to reach down through various parts and thicknesses of the earth's atmosphere, and to tell what alterations of constituents may be taking place there. To test this idea, a set of experiments was undertaken upon the absorbing action of vapours, gases, &c., upon the chemical component of the solar, electric, and magnesium light under known conditions in the laboratory, prior to their extension to an actino-chemical analysis of the atmosphere. The circumstances narrated below will cause the publication of the results, though in a somewhat incomplete state, at once.

§ IX. (3rd paper) was devoted to the "Influence of Heat upon the Decomposition of the Iodides." Three series of trials were instituted in this direction. The first was made before the *haupt role* played by oxygen in these decompositions was recognised. It consisted in noting the intervals through which the same amounts of potassium iodide, sulphuric acid, and starch liquor, diluted with 20 c.c. 60 c.c., and 100 c.c. water, ran through a scale of colours very faint rose, faint rose, rose, violet, and blue, as the temperature rose from 30° to 95°. On continuing the heating, the colours disappeared in inverse order, due to the gradual conversion of the indicator into dextrin under the influence of the dilute acid.

The second series of trials was upon the "Effect of Heat in Closed Flasks." Of course the use of starch was abandoned in these and subsequent trials. The final result obtained, to quote from the original paper, was that —"In other words, when potassium iodide was diluted 600 times, and heated nearly to the boiling-point (93°) in a closed flask for six hours, the amount of iodine set free was so small that it could not be estimated, and when diluted 1200 times no change whatever took place."

The third series was upon the "Effect of Heat in Flasks entirely Deprived of Air." The previous displacement of the air held in solution in the liquids was effected by a long-continued current of carbonic anhydride. When this was done the solutions of potassium iodide, both with sulphuric

and hydrochloric acid, were heated for two hours to a temperature five degrees above the boiling-point of water without any liberation of iodine whatsoever. Similar acidified solutions, heated to the same temperature in contact with air, turned *yellow immediately*.

IV. (3rd paper) was upon the "Decompositions Effected by the Electric Light. The experiments were performed by arranging the solutions in comparison tubes, so as to form the sides of a cylinder with the focus of the electric light at the geometric centre. The electric arc was taken between carbon-points, and was produced by electricity generated with a dynamo-electric machine run by steam-power, its illuminating capacity varying during the course of the experiment, according to photometric measurements made by Prof. Morton and Mr. Beckmayer, between 7000 and 7500 candles." Reducing the observations in the same manner as was done with the actinometric determination of sunlight, we have, the results being given in m.grms. of iodine :—

ACTINOMETRIC MEASUREMENT OF ELECTRIC LIGHT.

15 mins.	20 mins.	7½ mins.	Mean.	Ratios.
1 c.c. H_2SO_4+1 c.c. KI—				
1·65	3·90	3·00	2·85×0·43=1·22	
1 c.c. HCl+1 c.c. KI—				
1·05	3·40	2·00	2·15×1 =2·15	1 : 1·76
1 c.c. H_2SO_4+1 c.c. CdI_2—				
1·80	3·15	2·25	2·40×0·43=1·03	
1 c.c. HCl+1 c.c. CdI_2—				
1·25	2·50	1·35	2·02×1 =2·02	1 : 1·96

The same remarks are true of the chemical decompositions of the iodides effected by the electric, as when the decomposition resulted from the sunlight. But the amounts of iodine liberated in each trial were relatively several times greater, and the coefficient of chemical energy of the chlorine radical 1·86, instead of 1·46. This exaltation of the relative chemical energy of the chlorine under the influence of the electric light will be still more strikingly exhibited when the results obtained with rigorously equivalent solutions are published.

V. (3rd paper) was devoted to the "Comparison of Effects of Sunlight and Electric Light after passing through Absorbing Media." The experiments were performed as usual, except that the comparison-tubes were surrounded by a layer, 3 c.m. in thickness, of the absorbing medium—ammoniacal solution of copper for the blue, neutral potassium chromate for the yellow, and fuchsine for the red. They were made of such strength that the outlines of an object could be seen through them with equal distinctness, though in each case feebly. Reducing the observations as before, we have :—

EFFECT OF ABSORBING MEDIA.

Sunlight (1 hour).	Ratios.	Electric Light (1 hr.)	Ratios.
Blue : 1 c.c. H_2SO_4—			
2·38×0·43=1·02	1	6·00×0·43=2·58	1
1 c.cc. HCl—			
2·22×1 =2·22	2·2	4·50×1 =4·50	1·7
Yellow : 1 c.c. H_2SO_4—			
0·67×0·43=0·33	1	0·50×0·43=0·22	1
1 c.c. HCl—			
0·45×1 =0·45	1·4	0·45×1 =0·45	2
Red : 1 c.c. H_2SO_4—			
1·53×0·43=0·66	1	4·95×0·43=2·15	1
1 c.c. HCl—			
0·83×1 =0·83	1·3	3·00×1 =3·00	1·5

The fact most striking in this tabular view is, that while the greater strength of the actinic component of the electric beam is very manifest, the yellow absorbing medium absorbed 85 per cent of the actinic energy, which was transmitted through the blue solution, and 83 per cent of that which passed through the red. Of the actinic energy of the sunlight 32 per cent of that which passed through the blue was absorbed by the yellow, and 50 per cent of that going through the red. But the actinic energy of that part of the *sun's* actinism, which passed through the fuchsine, was but one-third of that of the *electric light*. I have said actinic energy rather than actinic rays, because the absorption-spectra for the invisible part of the spectra of the sun and electric light possessed by these substances, has, so far as I know, not been mapped. To quote from the original—"Better to understand what occurs in this instance, a study of the absorption-spectra (chemical) of the media and of the various iodides in the several portions of the sun and electric light, has been entered upon (February, 1879).

VI. (3rd paper) was upon the "Decomposition Effected by the Magnesium Light." Reducing the observations (one set obtained by an hour's exposure) to the same standard as before, we have :—

	M.grm. I.	Ratio.
1 c.c. H_2SO_4+1 c.c. KI	= 0·050 × 0·43=0·0215	
,, HCl ,, ,,	= 0·075 × 1 =0·075	1 : 3·5
,, H_2SO_4+1 c.c. CdI_2	= 0·035 × 0·43=0·015	
,, HCl ,, ,,	= 0·050 × 1 =0·050	1 : 3·3
,, H_2SO_4+1 c.c. LiI	= 0·040 × 0·43=0·017	
,, HCl ,, ,,	= 0·050 × 1 =0·051	1 : 3
,, H_2SO_4 + NH_4I	= 0·060 × 0·43=0·026	
,, HCl ,,	= 0·070 × 1 =0·070	1 : 3

The results were very surprising for their smallness, because the experiments were arranged in the same way as the electric light, the focus of the lamp being at the geometric centre of a cylinder, formed by the comparison-tubes, the cylinder being of 6 ins. radius. For while to the eye the white light of the burning magnesium was painful, the chemical decomposition effected by it was but the $\frac{1}{2\frac{1}{2}}$th part of that effected by the electric light during the same interval, and but $\frac{1}{7\frac{1}{2}}$nd part of that effected by the sun. The coefficient of comparative chemical energy exhibited by the chlorine atom under these circumstances is 3·2, as against 1·86 in case of the electric light, and 1·45 in that of the sun.

VIII. (3rd paper) was devoted to the "Comparison of Actinic Intensities for Equal Times." Reducing these observations as before, the amounts of liberated iodine being given in m.grms., we have :—(See Table on next page).

These phenomena are graphically represented in the accompanying diagram, the observed results being taken for abscissæ and ordinates, and the magnesium ordinates multiplied by 10 to bring its curve up into the field of view.

SUMMARY.

I. The part played by oxygen is the essential fact in the decomposition of soluble iodides in acidified solutions, no decomposition taking place either in darkness or in the strongest sunlight, in case oxygen is absent. The principal exception to the rule is when nitric acid is employed.

II. In case oxygen is present, the reaction takes place according to the equation—

$$4MI+4HA+O_2=4MA+2H_2O+2I_2,$$

where M stands for any monovalent basic radical, and A a monobasic acid radical. This is true of the solutions both in darkness and in light.

III. In case sufficient oxygen is present to permit of a normal reaction, the amount of iodine liberated in the darkness is strictly proportional to the degree of concentration up to the limit to which the above equation is true. In the light the same law holds good; the surface of exposure and the quantity and intensity of the light remaining the same, the degree of concentration the variable.

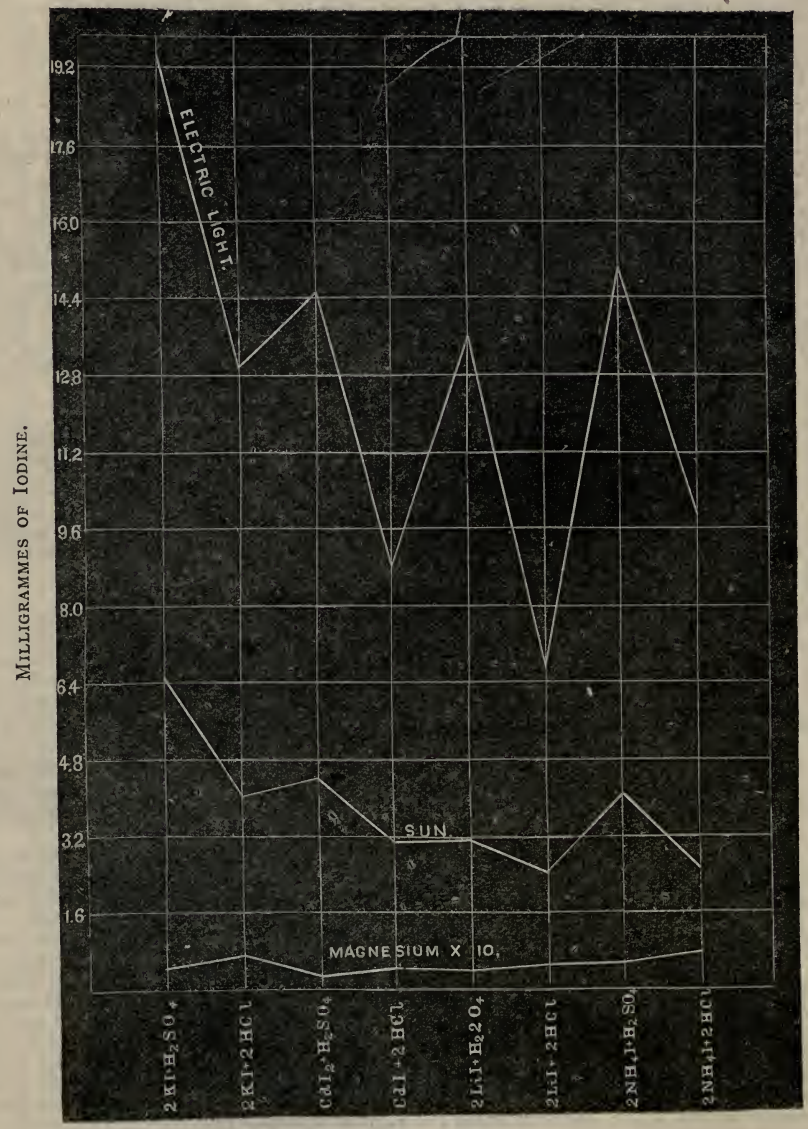
IV. In case sufficient oxygen is present and the degree of concentration is fixed, the amount of iodine liberated increases in the same ratio as the time of exposure to the light. There is likewise much reason for supposing that it stands in a similar numerical relation to the number and intensity of the chemical rays falling upon the solution.

V. With a constant actinic energy and with equivalent solutions of acids, the amounts of iodine liberated differ

DECOMPOSITION DURING EQUAL TIMES (1 HOUR).

Reagents.	Electric Light.		Sun.		Magnesium.		Ratios.
	Observed.	Reduced.	Observed.	Reduced.	Observed.	Reduced.	
H_2SO_4+KI	19·5	12·38	6·5	2·3	0·05	0·022	560 : 100 : 1
HCl „	13·0	13·00	4·0	4·0	0·075	0·075	173 : 53 : 1
H_2SO_4+CdI_2	14·6	6·28	4·4	1·9	0·035	0·015	420 : 126 : 1
HCl „	8·8	8·8	3·0	3·0	0·05	0·05	176 : 60 : 1
H_2SO_4+LiI	13·7	5·99	3·1	1·3	0·04	0·017	350 : 83 : 1
HCl „	6·5	6·5	2·4	2·4	0·05	0·05	130 : 48 : 1
H_2SO_4+NH_4I	15·0	6·45	3·9	1·7	0·06	0·026	248 : 65 : 1
HCl „	9·8	9·8	2·3	2·3	0·07	0·07	140 : 33 : 1
Means of H_2SO_4							395 : 94 : 1
„ „ HCl							155 : 50 : 1
„ „ all							275 : 72 : 1

FIG. III.



MILLIGRAMMES OF IODINE.

REAGENTS.

by constant quantities, which appear to be coefficients of comparative chemical energy of the acid radicals under these conditions. A similar law appears to apply to the various basic radicals of the iodides in the presence of the same acid.

VI. In the absence of oxygen no decomposition takes place, either in light or darkness, nor in dilute nor quite strong solutions, when the solutions are *heated* for hours to a temperature 5° above the boiling-point of water. In the presence of oxygen instantaneous and abundant decomposition sets in at this temperature and correspondingly at lower temperatures.

Applications of the Iodo-Acid Method.—1. To determine the amount of chemical work done by the sun's rays while passing through various layers of the earth's atmosphere, either during each hour in the same day at any given place, or at different places for each day and season of the year. Curves representing such actinometric measurements at Hoboken for January 22 and 24, 1879, and February 27, 1879, are given.

2. To determine the absorptive coefficients for the chemical rays of the sun (or other powerful actinic light) of various gases, vapours, &c., under known conditions in the laboratory, and then apply the knowledge thus obtained to an actino-chemical analysis of the atmosphere.

3. To map the actinic spectra of the sun, electric, magnesium, and other powerfully actinic illuminants, and the absorption-bands for the invisible rays, when the light from these sources passes through solids, mineral and organic compounds in dissolved or liquid form, and vaporous or gaseous bodies.

4. To determine the comparative coefficients of combining and decomposing power of elements in compounds subject to metathesis by actinic forces, and to find these actino-equivalents for invisible rays of various refrangibility.

After the extended account published in the June number of the *Philosophical Magazine* for 1879, and sent about the same time to different gentlemen in Europe, I was very much surprised when I saw an article published in the Chemical News, vol. xli., p. 211, being a paper read before the Royal Society, April 29, 1880, by Dr. R. Angus Smith, in which, beneath the title "Measurement of the Actinism of the Sun's Rays and of Daylight," he gives an account of a process, which in every point runs parallel with and coincident with my own, except in several important omissions. This, I think, will appear on consideration of the following resumé of Dr. Smith's work. He states:—"The fundamental fact is that when iodide of potassium in solution is treated with nitric acid, so small in quantity as to cause no change of colour in dull diffused light, a change takes place when the same mixture is brought into clear light; iodine is set free and the solution becomes yellow. The amount of iodine set free can be titrated with great exactness by the use of hyposulphite, as is well known. In these two facts lies the whole process, the first is the new part, the second makes the first quantitative, and it is of course part of the novelty."

I admit the novelty exhibited by Dr. Smith, in selecting, of all others, nitric as the acid forming part of the fundamental fact of the process as he states it. For it is true that in the 128 determinations of the iodine liberated from four iodides in the presence of sulphuric and hydrochloric acids and titrated by the use of standard (1 c.c.=5 m.grms. I) sodic hyposulphite and 1-10th standard, these 128 determinations being all made in one day, February 27, 1879, I did not use nitric acid. And the reasons for i's omissions are stated in many places (2nd and 3rd papers). For, while the reaction in dilute solution (Eq. 2, § X., 3rd paper) for sulphuric acid is—

$$4KI+2H_2SO_4+O_2=2K_2SO_4+2H_2O+2I_2,$$

and for hydrochloric acid (Eq. 6)—

$$4KI+4HCl+O_2=4KCl+2H_2O+2I_2,$$

that for nitric acid is not only the normal one of—

$$4KI+4HNO_3+O_2=4KNO_3+2H_2O+2I_2 \text{ (Eq. 3)},$$

but the secondary ones, $2HNO_3=N_2O_4+H_2O+O$, o $2HNO_3$ (in sunlight) $=N_2O_3+H_2O+O_2$ (Eq. 4)* and $2KI+2HNO_3+N_2O_3=2KNO_3+H_2O_2+N_2O_2+I_2$ (Eq. 5). It had been abundantly demonstrated by many experiments (what was well known before) that nitric acid of itself, no iodides being present, spontaneously breaks up into one or more lower oxides of nitrogen and free oxygen in the sunlight, and generates in the body of the solution itself an abnormal supply of that oxygen, which, to my way of thinking, is the fundamental factor in these cases of actino-chemical change. Later on, Dr. Smith suspects that the nitric acid itself in dilute solution was subject to decomposition, and substitutes for his new and fundamental fact the use of sulphuric acid. I think Dr. Smith will grant that this is not new, inasmuch as he will find it stated at great length, *Phil. Mag.* for 1879, p. 396. Neither, however, is it fundamental, for an equivalent amount of hydrochloric acid possesses a greater coefficient of iodine-liberating power when placed in an actinic field.

Dr. Smith furthermore states:—"3. It is known that strong acid liberates iodine. Weak acid does so after a long time, but the process is hastened by light." This generalised statement may lead to confusion and error, if left unqualified by a precise idea of the conditions under which it is false, and those under which it is true. For when oxygen is excluded,† "decomposition of an acid solution of potassium iodide occurs only after the concentration has attained to some point between one-third and one-tenth the weight of the water employed."

The acidifying body referred to in the experiments quoted, is sulphuric acid, and a more precise limit of concentration is not given, because of the undue multiplication of trials thereby entailed. But decomposition ensues in this instance from the production of an entirely different set of conditions on the attainment of the limit, and the sulphuric acid splits up, thereby furnishing the essential oxygen by an endo-chemical change. Instead of—

$$4KI+2H_2SO_4+O_2=2K_2SO_4+2H_2O+2I_2$$

(Eq. 2, §X., 3rd paper), the equation given for this case is $2KI+2H_2SO_4=K_2SO_4+2H_2O+SO_2+I_2$ (Eq. 1).

With regard to the statement that weak acid liberates iodine after a long time, but the process is hastened by light, it appears to the author that herein is contained the fundamental proposition of Dr. Smith's labours, and that as such it demanded elaborate experimental verification. For, although in a qualified sense the proposition is true, yet the working out of the exact conditions under which it holds good constituted the preliminary and most laborious portion of the work performed by the author in the three papers previously referred to and in others following them. Moreover, if these facts and conditions be so well known and generally accepted that a method of actinometry might be founded upon them without independent proof, yet the evidence of their being commonly ignored is to be seen in the very frequent publication of erroneous observations and conclusions concerning processes in which soluble iodides are concerned. Let me instance again the bitter controversy between Schönbein and Fischer, Houzeau and Sauvage, as to the *fact* of a dilute potassium iodide solution being decomposed in the presence of very dilute sulphuric acid.‡ More

* Gay-Lussac states that the decomposition is into nitrous acid. He adds that nitric acid, whose density is as low as 1·3235, is not decomposed by light, except in the presence of a certain quantity of concentrated sulphuric acid, when even the most dilute acid undergoes change. *Ann. Chim. Phys.*, vol. i., p. 397, 1816.

† "Upon the Detection and Estimation of Nitrous Acid in Potable Waters, Acids, &c., with Potassium Iodide," by the Author, Chemical News, vol. xl., p. 61; *J. Amer. Chem. Soc.*, i., p. 136.

‡ I would ask the gentlemen concerned, in the controversy alluded to in this reference, to refer as far back as 1840, to the article by Schönbein entitled "Researches on the Nature of the Odour given off by certain Chemical Reactions" (*Comptes Rendus*, x., p. 706; *Froriep. Notizen*, xix., p. 292; *Ann. Elec.*, vi., p. 108); also to his article upon the "Production of Ozone by Chemical Means," 1844 (*Arch. de l'Elec.*, iv., pp. 333 and 454). Let me ask them to read likewise the critique by Fischer (*Berl. Jahrb. f.*

striking still, the universal employment of an acidified solution of potassium iodide for titrating a currrent of air or oxygen, carrying with it ozone, or ozone and peroxide of hydrogen. It is but a few weeks ago since in certain experiments instituted to discover whether or no ozone is given off by the slow oxidation of phosphorus in moist air, the most abundant reaction for ozone was obtained when the current of ozonised air was heated to 200°, before its passage into an acidified solution of potassium iodide. But at a temperature of 200°, 97 per cent of the ozone present in ozonised air or oxygen, is *destroyed at once*, and the residue very speedily.*

If more evidence were needed to show that the spontaneous decomposition of a soluble iodide in presence of dilute acid and oxygen is a fact generally ignored, it is to be found in the tests recommended in "Fresenius's Qualitative Analysis" for the detection of free chlorine in hydrochloric acid, and of hyponitric in sulphuric acid: the latter "when diluted with twenty parts of water must not impart a blue tint to a solution of iodide of potassium mixed with starch paste."* "But if the trial be made in an atmosphere of carbonic acid, care being used to expel previously all traces of air in reagents and in the dilute acid solution, the test and estimation of percentage may be satisfactorily performed."† A like proof may be found in the customary mode of applying Trommsdorf's method for the detection and estimation of "Nitrous Acid in Potable Waters."‡ When the zinc-iodide starch reagent and water under examination are left without previous expulsion of dissolved oxygen, the amount of iodine set free by spontaneous decomposition, even in the diffused light of a laboratory, may much exceed the total quantity of nitrous acid present. In truth, an amount admitting of quantitative determination may apparently be found when, as examined by the Griess test (meta-diamidobenzol), not a trace of nitrous acid is actually present.

Finally, examine in this connection the admirable memoir of Schöne "Upon the Quantitative Estimation of Hydrogen Peroxide."‖ For in one series of trials this investigator employs concentrated solutions of potassium iodide and hydrochloric acid to determine minute amounts of hydrogen peroxide dissolved in different quantities of water. In another series the solutions were boiled in contact with the air, and the amounts of hydrogen peroxide found, which in most trials exceeded the quantities taken, corrected by a figure obtained by boiling similar solutions, *but containing no hydrogen peroxide*, during an

---

Wissensch. Kritik., 1844) upon Schönbein's pamphlet "Ueber die Erzengung des Ozons auf Chemischen Wege," followed as it was by a second attack from the *savan* of Breslau (*Schles. Gesell. Uebersicht.*, pp. 98 and 107; *Pog. Ann.*, lxvi., p. 163; *J. Pr. Chem.*, xxxv., p. 351), in which he advanced the hypothesis that the ozone discovered by Schönbein was probably a peroxide of hydrogen. We have seen how, thirty-five years later, this hypothesis was again brought forward by Mr. Kingzett, without reference to the battle of these illustrious teachers of a past generation, and without comment upon Schönbein's reply to Fischer's attack (*J. Pr. Chem.*, xxxiv., p. 492; *Pog. Ann.*, lxv., p. 190), Mr. Kingzett asserting that "*there is no known process of slow oxidation which has been established to produce ozone*," and that the substance formed in the aërial oxidation of phosphorus is peroxide of hydrogen. Whilst the controversy was raging in Germany between Schönbein and Fischer, it was opened in England by Prof. Williamson's "Researches on Ozone" (*Chem. Soc. Mem.*, ii., p. 395; *Liebig's Ann.*, liv., p. 127; *Phil. Mag.*, xxvii., p. 372; *Comptes Rendus*, March, 1845), in which Dr. Williamson states, as the result of elaborate experiments performed with exceeding care, that there were reasons for believing in the existence of two kinds of ozone,—one, the ozone given off in electrolysis, and which he regarded as a higher oxide of hydrogen, differing from the previously well-known peroxide, and the other formed by the action of phosphorus on moist air. I cannot regard the rejoinder of Schönbein (*Pog. Ann.*, lxvi., p. 292; *Phil. Mag.*, xxvii., p. 450)—in which he showed, 1st, that the chemical and physical properties of ozone are not the properties of peroxide of hydrogen; and 2nd, that whatever might be the true nature of ozone, the gaseous matter obtained in the electrolysis of water was in all respects identical with that formed by the action upon air of moist phosphorus—otherwise than as a masterpiece of cogent reasoning, and as an argument for *the identity of ozone from whatever source produced* even at the present day unsurpassed. His eminent English antagonist never replied, and the doctrines of Schönbein on this point passed into the text-books, and remained there without a dissenting voice, until—unsupported by any show of evidence that he had performed more precise experiments on his own part, or that he had in any particular demonstrated errors in the work of those whom he so attacked—Mr. Kingzett pronounced them false. Perhaps even more surprising, as certainly more novel, are the polemical methods adopted by Prof. McLeod. For, stepping down unasked of the two principals in the contest, into this particular arena of controversy, and without even the fine courtesy traditional to a free lance of previous salutation, by name or token of reference, Prof. McLeod proceeds forthwith to demolish his two antagonists, and makes them both to be in error. This too without invoking, by *as much as a single footnote*, the shades of the mighty contestants who took part in the much greater battle fought on these points, more than a quarter of a century before, to be spectators of the fray. The historical aspect of this important question is of great interest. In 1853, Baumert thought he had succeeded in proving the existence of two kinds of ozone; the one prepared by the electric discharge, which he regarded as allotropic oxygen; the other afforded by the electrolysis of acidulated water, to which he assigned the formula H_2O_3—teroxide of hydrogen. (Breslau, *Schles. Gesell. Verhandl. Uebersicht.*, 24; *Ann. de Chim. et Phys.*, xxxix., p. 477; *J. Pr. Chem.*, lix., p. 350; *J. de Pharm.*, xxiv., p. 381; *Phil. Mag.*, vi., p. 51; *Ann. der Chem. u. Pharm.*, lxxxviii., p. 221; *Pog. Ann.*, lxxxix., p. 38.) He passed the electrolytic oxygen, evolved in such a manner as to exclude the presence of hydrogen, through a very long sulphuric acid tube, and thence into an absorption apparatus containing *potassium iodide*, and provided with a proper sulphuric acid guard. In case the matter of ozone and oxygen were identical, the weight of oxygen equivalent to the weight of iodine set free by the ozone should have been equivalent to the total gain in weight by the absorption apparatus. But, according to the experiments, this weight was less, and the numbers apparently assigned to electrolytic ozone the formula H_2O_8. Three years later the conclusions of Baumert were overthrown by Andrews, in his classic research upon the "Constitution and Properties of Ozone." (*Phil. Trans.*, 1856, p. 1; *Royal Society Proc.*, vii., p. 475; *Ann. de Chim.*, xlvii, p. 181; *Journ. de Pharm.*, xxx., p. 3; *Ann. der Chem. und Pharm.*, xcvii., p. 371; *Pog. Ann*, xcviii., p. 435.) He demonstrated the fatal error in Baumert's experiments, in that the electrolytic ozone had contained a minute but determinable quantity of carbonic acid, which, unless exceeding precautions be taken, is always present in the evolved gas. Finding that the results obtained with a *neutral solution of potassium iodide* varied irrationally and uncontrollably, Andrews in despair abandoned the use of the *neutral*, and substituted a slightly *acidified* solution. The free hydrochloric acid prevented the fixation of any traces of carbonic anhydride by the liberated base of the iodide, the anomalies disappeared, and by very numerous experiments he succeeded in establishing that the weight of the substance which produced the decomposition (the active oxygen or ozone) was exactly equal to the weight of the iodine set free, and therefore no hydrogen as well could have been present. The fact that the foregoing, which is the main truth, was thus triumphantly established by Andrews has probably been the reason why the method he followed (of titrating ozone in an acidified solution of iodide) has been generally adopted and practised, even up to the present day, with, as we have previously seen, the commission of very serious error. For while Baumert failed in his reply (*Pog. Ann.*, xcix., p. 88) to invalidate the principal conclusion of Andrews, he nevertheless did succeed in experimentally proving that all of them were vitiated by a constant error. Baumert showed that when a stream of electrolytic ozone was passed through three absorption apparatus, the first and second containing a neutral, the third an acidified solution of potassium iodide, all the ozone underwent decomposition in the first, no iodine whatsoever was liberated in the second, but in the third—*the acidified solution*—an amount of iodine was set free equivalent to many times (from four to ten) that corresponding to the ozone reaction in the neutral solution. This last Baumert correctly ascribed to the decomposing action of oxygen upon an *acidified* solution of potassium iodide, and the curious fact remains that both the total increments in weight due to the fixation of absorbed ozone (and oxygen), and the amounts of oxygen as determined by titration equivalent to the iodine liberated, were both false in Andrews's experiments, and in excess of the absolute quantities of ozone operated upon. Yet inasmuch as these two weights—in the absence of an extraneous third body, like carbonic acid, which could be fixed by the titrating fluid—were necessarily equal, the constant error in Andrews' results did not excite general attention. Fortunately, as above remarked, the conclusions arrived at by Andrews were true, and the accompanying fallacy—concealed beneath the halo surrounding a great name—was perpetuated in the works of later experimenters, and has led many astray. Ten years later than the memoir referred to, the facts made known by Baumert, concerning the decomposition of an acidified iodide solution in the presence of oxygen, were re-discovered by Payen (*loc. c t.*), who extended his trials to the action of acetic, nitric, oxalic, and other acids in dilute conditions, upon solutions of potassium iodide in and out of contact with air, but without accompanying them with the beautifully quantitative methods of Baumert. While both experimenters noted the essential participation of oxygen in the change, they appeared to have overlooked the role of actinism.

Since writing the above I have found (CHEMICAL NEWS, xxxvi., p. 110, from *Gazz. Chim. Italiana*, vii., fasc. vi.) a note entitled "Action of Light and Carbonic Acid upon Aqueous Solutions of Iodide of Potassium, and on Ozonoscopic Paper," by G. Peelagri. I am unable to judge, from this short note, to what extent the above results have been anticipated by the Italian experimenter, and I have no means of present access to the original paper.

* "Peroxide of Hydrogen and Ozone," CHEMICAL NEW
† "Fresenius's Qualitative Analysis," 6th ed. ,pp. and 3
‡ CHEMICAL NEWS, vol. xli., p. 63; *Ibid.*, p. 62.
‖ *Zeitsch. für Anal. Chem.* vol. xviii. (1879), p. 1

equal interval. True values, it appears to me, might have been found in both series of trials had the experiments been performed with the exclusion of every trace of oxygen from the solutions. It is the more surprising, inasmuch as in the same article this most careful experimenter calls attention to the method of Gernez* for freeing solutions of oxygen by a current of an indifferent gas, and the experiments of Baumert,† Payen,‡ and Lehmann‖ upon the decomposition of hydriodic acid by oxygen.

Dr. Smith goes on to state—4. "Heat even to the boiling-point does not act so well as light (experiments being made in sealed tubes to prevent loss of iodine)." Unfortunately, Dr. Smith could not have arranged the conditions of his experiment in a manner better calculated to lead to false conclusions. For, in sealing up the tubes, he prevented the access of oxygen, the very element whose presence is essential to the occurrence of the reaction with dilute solutions, whether the experiment be performed in light or darkness, in the heat or cold. And the sum total of the iodine which Dr. Smith could have liberated under the conditions given, even had the tubes been kept at the boiling-heat or several degrees above (see results obtained at 105°, *supra*) for hours, would have been the small amount equivalent to the oxygen sealed up at the same time with the solutions in the tubes.

It is possible that, in the experiment performed by Dr. Smith, a small amount of the dilute nitric acid may have undergone decomposition by heating into hyponitric acid and oxygen. But this is extremely improbable, and there is reason for believing that the total amount of iodine set free in the experiment cited was the exact chemical equivalent of the oxygen of the air which was sealed up at the same time with the acidified solution in the tube. And, as a corollary to this proposition, had Dr. Smith taken the precaution to exclude every trace of free oxygen from the tube, even with the dilute nitric acid no change of the potassium iodide solution would have occurred on heating to the boiling-point, and on continuing the heating for hours.

The seventh point is: "The solution of iodide of potassium as hitherto obtained is subject to change. An old solution—that is, one nearly a month old—was found more sensitive than a new one in all cases tried." I find it difficult to understand the precise meaning of the epithet "sensitive" as applied in this connection, unless the sensitiveness be due to a decomposition of the nitric acid employed, and a corresponding liberation of iodine. Instead of being styled sensitive, the solution might with more propriety perhaps be termed spoiled, and as such unfit for employment in actinometry.

Dr. Smith states, in the ninth place, "The amount of allowance for temperature is not made out. It is not certain that any is required in the cases when weak acid is used. The weather has not allowed any combined action of great light and heat; but with heat and light in the rays from an electric light with a parabolic reflector the action was very rapid." I do not find in the experiments detailed by Dr. Smith upon the effects of temperature (see above) a basis for the above generalisation. Neither do I perceive the reason for this dependence upon the weather, when it might be deemed the essential pre-requisite of accurate experiment that the changes due to the two separate causes should be carefully discriminated, and the effects properly assignable to each determined by previous trials under conditions admitting of exactitude and control. Nor do I recognise a test of the latter character in the experiment performed in the concentrated beam from an electric light.

Finally, the manner in which the iodo-acid method is applied to solar actinometry appears irrational. For Dr. Smith proposes to expose this actinometer during successive hours of "sunshine and cloud alternately"—during times when the weather is "changeable," during intervals of "sun and showers," during weather which is "foggy, with a gleam of sunshine." In what way is the value of a meteorological observation enhanced by knowing that, during periods in which the sun may or may not have been shining, a few milligrammes more or less of iodine were set free in an acidified solution?

When, however, we call to mind the frequent experience in photography, that there are states of the atmosphere when, with a clear sky, the quality of the light does not appear to be favourable to the making of a successful picture; or the fact previously noted, that, no visible change being manifest in a brilliant blue sky, the curve of chemical intensity underwent a great depression; or note the immense amount of chemical work done as the horizontal ray passes through the myriad organisms and pestilential germs, miasms, vapours, and countless emanations from the earth's surface that admit of oxidation under solar influence,—then, I think, we become impressed with the large practical value of an easy and rapid method of actinometry. The actinic component of the solar ray has its units of work, as well as the thermal, and the day has come when, in the utilisation of available energy, it will repay us to economise the forces in the sunbeams at present wasted.

* *Comptes Rendus*, lxiii., p. 883; *Zeitsch. f. Chem.* [2], ii., 717.
† *Pog. Ann.*, xcix., p. 92.
‡ *Comptes Rendus*, lxii., p. 254.
‖ *Arch. Pharm.* [3], ii., p. 25; *Chem. Centr.*, 1873, p. 152.

REPLY TO DR. LEEDS'S CRITICISM.

By R. ANGUS SMITH, F.R.S.

A PRELIMINARY notice of an enquiry madeby me was lately published in the *Proceedings of the Royal Society*: it was on a mode of measuring the actinism of the sun's rays and of daylight. It appears that nearly the whole purely chemical part of the investigation, and more besides, was made previously by Dr. Leeds, of Philadelphia, and I suppose I ought to have known of it. However, amongst the many things to be read, I overlooked it, and the best proof is that I sent my results to the Royal Society, where no man would knowingly send another man's work; and it was so little known here, that, like myself, no one recognised Dr. Leeds's work in it, so far as I know. The real reason may lie in Dr. Leeds not seeing fully the bearing of his work, and so not calling attention to the points that interested me: a quotation to follow explains this. When two men with good eyes go on the same road they see the same things: in scientific matters this is common enough, and no one is to blame if only the second and following give due credit to the first as soon as they know his precedence. When I look at Dr. Leeds's work, it shows a fulness and completeness which mine cannot claim, and I greatly admire his investigations. His aim was different from mine, but I think mine would easily have come out of his. He must not forget that I was seeking a practical result for a manufacturing country. At the same time I think that Dr. Leeds has taken unnecessary trouble to criticise my preliminary note, although of course it was necessary to assert his priority. As to the rest of the literature, I should never have thought of introducing it; I passed it over with an allusion. In a preliminary note one does not enter on history, and how much I would have said in the full memoir intended I cannot say. I sent only bare notes; these notes are bare to save time; longer memoirs are sometimes useful, but are less read. However, Dr. Leeds objects to my results, and therefore, I suppose, does not claim them wholly, although I think he fairly might. The enquiry is to my mind a very neat one; I may speak of it freely now, as I will readily call it by Dr. Leeds's name, at least so far as the decomposition goes, or altogether if he prefers, although he rejects the conclusion.

I had for some years been seeking a mode of measuring the light in a smoky town compared with that in the country around, and have talked on the subject, but never

found a method suitable. This one arose out of a discussion chiefly among photographers several years ago as to the decomposition of nitrates in sunlight. I thought of measuring it, but found nitrates unnecessary in association with the iodide. Still the real work is only from last winter. Dr. Leeds came by another way I suppose, but still he was before me, and I am sorry I did not know it, and yet he kindly sends me his papers. Well, if he sent this I must have overlooked it. Had I seen it I would have leapt at it as the very thing I so long *desired*. He does not seem to me to value his process sufficiently. But while I thus freely give all the observations to Dr. Leeds, it is still to be explained why neither I nor anyone I know of had found from his papers the value of the process. Indeed, he even now objects to this as a meteorological instrument, because he says—"In what way is the value of a meteorological observation enhanced by knowing that during periods in which the sun may or may not have been shining a few milligrammes more or less of iodine were set free in an acidified solution?"

Now this is the very thing which I pretend to see, and I suppose solves the difficulty. I do not intend to expose the solutions to sunshine and cloud alternately, as Dr. Leeds supposes; the alternations alluded to are those of the weather. We do not always notice every decomposition explained by writers when the result is not shown to have an important bearing. Still, I am surprised at what Dr. Leeds says on this, because when I now read the extracts from his papers it seems to me clear that he *was measuring the actinism of the daylight, and making important observations in meteorology*, and he is not doing himself justice. When the solutions are exposed all day the decomposition goes on, so far as I can make out, exactly according to the amount of sunlight. If a cloud comes the decomposition diminishes; if the cloud is very dark, or if there is a fog, requiring us to light gas, no decomposition appears. There is a haze line which I should be glad to measure, at which line no result is given.

Dr. Leeds brings in the ozone theories. I have wasted much time on ozone. In my paper alluded to I avoid carefully all theories, and Dr. Leeds will see, if he reads more carefully, that I am quite aware of the action of oxygen, and I may add that the amount of iodine freed in the heat used had no relation to the amount of oxygen.

The remark on this by Dr. Leeds seems to lead to wrong conclusions. Many thoughts passed through my mind before I decided to overleap in my notes a great desert of chemical enquiry. I not only learnt that oxygen was necessary, but my trials showed that all the oxygen could not be used for the purpose, and I consider that I found that ozone was not the agent. In fine, it led me to a region of speculation regarding which I prefer to be silent until I learn something; whether it be the silence of ignorance or not, it is not well to remark it, but ignorance it happens to be. I shall go on with my practical work, and I hope to persuade Dr. Leeds of the value of this process in meteorology, although obstructions unforeseen may take place. On this point, perhaps, I do not understand him well, although I have quoted correctly. I am applying it to the testing of the purity of water, as it surpasses in suitable cases the colorimetric methods. He may depend on full justice from me, and I certainly desire no more. And while I thus express myself, I cannot help adding thaf I am much pleased at once to recognise Dr. Leeds's prior claims, even although there are some hints in the article which might have been left out, and I hope he will be satisfied with me in carrying out the process for the practical purposes which I have before me. As my desire was to find the meteorological results to which I allude, whilst I searched for a method by others, so my wish now is to see the value of that fixed on. Dr. Leeds well knows that the examination of the air of town and country has been interesting to me all my life; but it requires one to leave the style of science and to enter on literature more than is usual, in order to explain the strange conjunction of lines of thought in man's mind, leading chemists as well as others to be deaf for a while to words spoken or written and to follow their own ways, to which they seem pleasantly guided by nature. A great man, Priestley, used to forget altogether his own enquiries, whilst he still retained his usual vigour, and in haste it happens that one equally great may be deprived of his due attention, but as soon as it is discovered, good feeling and common sense soon put the matter in its proper light.

July 24, 1880.

Royal 32mo., Roan, gilt edges, price 5s.

A POCKET-BOOK

FOR

Chemists, Chemical Manufacturers, Metallurgists, Dyers, Distillers, Brewers, Sugar Refiners, Photographers, Students, &c., &c.

By THOMAS BAYLEY, Assoc. R. C. Sc. Ireland.

Synopsis of Contents.

Atomic Weight and Factors—Useful Data—Chemical Calculation—Rules for Indirect Analysis—Weights and Measures—Thermometers and Barometers—Chemical Physics—Boiling-Points, &c.—Solubility of Substances—Methods of obtaining Specific Gravity—Conversion of Hydrometers—Strength of Solutions by Specific Gravity—Analysis—Gas Analysis—Water Analysis—Qualitative Analysis and Reactions—Volumetric Analysis—Manipulation—Mineralogy—Assaying—Alcohol—Beer—Sugar—Miscellaneous Technological Matter relating to Potash, Soda, Sulphuric Acid, Chlorine, Tar Products, Petroleum, Milk, Tallow, Photography, Prices, Wages &c., &c.

London: E. and F. N. SPON, 46, CHARING CROSS.

Crown 8vo., 600 pp., with 470 Wood Engravings, 12s. 6d., cloth.

THE STUDENT'S TEXT-BOOK of ELECTRICITY. By Henry M. Noad, Ph.D., F.R.S., F.C.S. New Edition, carefully Revised. With an Introduction and Additional Chapters, by W. H. Preece, M.I.C.E., Vice-President of the Society of Telegraph Engineers, &c.

"A reflex of the existing state of electrical science, adapted for students."—*W. H. Preece, Esq., in Introduction.*

"We can recommend Dr. Noad's book for clear style, great range of subject, a good index, and a plethora of woodcuts. Such collections as the present are indispensable."—*Athenæum.*

"Dr. Noad's text-book has earned for itself the reputation of a truly scientific manual for the student of electricity, and we gladly hail this new amended edition, which brings it once more to the front."—*Telegraphic Journal.*

"The work contains everything that the student can require, it is well illustrated, clearly written, and possesses a good index."—*Academy.*

"An admirable handbook."—*Westminster Review.*

CROSBY LOCKWOOD and CO.,
7, Stationers' Hall Court, London, E.C.

Just published (London: J. and A. CHURCHILL), price 16s.

A HANDBOOK OF MODERN CHEMISTRY. By Charles Meymott Tidy, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital.

CHEMICAL LABORATORY,

WIESBADEN, GERMANY.

Director—Prof. R. FRESENIUS, Ph.D.

LECTURES.

Experimental Chemistry (Inorganic)	Prof. R. FRESENIUS, Ph.D.
Experimental Physics	W. FRESENIUS, Ph.D.
Organic Chemistry Theoretical Chemistry	H. FRESENIUS, Ph.D.
Chemical Technology	E. BORGMANN, Ph.D.
Mineralogy	F. HENRICH.
Microscopy, with exercises in microscopic work	E. BORGMANN, Ph.D.
Practical Instruction in the Laboratory	Prof. R. FRESENIUS, Ph.D., H. FRESENIUS, Ph.D., and two Assistants.

The next Session commences on the 15th of October. The Regulations of the Laboratory and the Syllabus of Lectures will be forwarded gratis on application to C. W. Kreidel's Verlag, at Wiesbaden, or to the undersigned.

Prof. R. FRESENIUS, Ph.D.

THE CHEMICAL NEWS.

Vol. XLII. No. 1087.

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION OF THE BRITISH ASSOCIATION.

By Prof. W. GRYLLS ADAMS, M.A., F.R.S.
President of the Section.

It has been said by a former President of this Section of the British Association that the President of a section ought to occupy your time, not by speaking of himself or his own feelings, but by a review "more or less extensive of those branches of science which form the proper business of this section." He may give a rapid sketch of the progress of mathematical science during the year, or he may select some one special subject, or he may take a middle course, neither so extensive as the first nor so limited as the second.

There are many branches of science which have always been regarded as properly belonging to our Section, and the range is already wide; but it is becoming more and more true every day that the sciences which are dealt with in other sections of the Association are becoming branches of physics, *i.e.*, are yielding results of vast importance when the methods and established principles of physics are applied to them. I wish to direct your attention to investigations which are being made in that fertile region for discovery, the "border land" between chemistry and physics, where we have to deal with the constitution of bodies, and where we are tempted to speculate on the existence of matter and on the nature of the forces by which the different parts of it are bound together, or become so transformed that all resemblance to their former state is lost. It is not long since the theory of exchanges became thoroughly recognised in the domain of radiant heat, and yet it is already recognised and accepted in the theory of chemical combination. Just as the molecules of a body which remains at a constant temperature are continuously giving up their heat motion to surrounding molecules, and getting back from them as much motion of the same kind in return, so in a chemical compound which does not appear to be undergoing change, the combining molecules are continuously giving up their chemical or combining motions to surrounding molecules, and receiving again from them as much combining motion in return. We may say that each molecule is, as far as we can see, constantly dancing in perfect time with a partner, and yet is continuously changing partners. When such an idea of chemical motion is accepted, we can the more easily understand that chemical combination means the alteration of chemical motion which arises from the introduction of a new element into the space already occupied, and the consequent change in the motion of the new compound as revealed to us in the spectroscope. We can also the more readily understand that in changing from the old to the new form or rate of motion, there may be a development of energy in the shape of heat motion which may escape or become dissipated wherever a means of escape presents itself. We know from the experiments of Joule and of M. Favre that as much heat is absorbed during the decomposition of an electrolyte as is given out again by the combination of the substances composing it.

We are making rapid strides towards the exact determination of those relations between the various modes of motion or forms of energy which were so ably shadowed forth, and their existence established long ago, by Sir William Grove in his Correlation of the Physical Forces, where, in stating the conclusion of his comparison of the mutual interchange of physical forces, he distinctly lays down the principles of energy in this statement. "Each force is definitely and equivalently convertible into any other; and where experiment does not give the full equivalent, it is because the initial force has been dissipated, not lost, by conversion into other unrecognised forces. The equivalent is the limit never practically reached."

The laws of Faraday, that (1) when a compound is electrolysed the mass of the substance decomposed is proportional to the quantity of electricity which has produced the change, and that (2) the same current decomposes equivalent quantities of different substances, *i.e.*, quantities of their elements in the ratio of their combining numbers, have given rise to several determinations of the relation between chemical affinity and electromotive force. In a paper lately communicated to the Physical Society, Dr. Wright has discussed these several determinations, and has given an account of a new determination by himself. The data at present extant shew that when 1 grm. of hydrogen unites with 7·99 grms. of oxygen there are about 34,100 units of heat given out, making the latent heat of dissociation of 1 grm. of water equal to 3797 units. The results obtained are compared with the heat given out by the combustion of hydrogen and oxygen, and the value of the mechanical equivalent of heat is deduced from these determinations.

The value of this mechanical equivalent obtained by Dr. Wright, which depends on the value of Clark's standard cell, and therefore depends on the value of the ohm, agrees fairly well with Joule's determination from the heat produced by an electric current in a wire, but is greater than Joule's value as obtained from his water-friction experiments. This may be accounted for by supposing an error in the value of the ohm or B.A. unit, making it too large by 1·5 or 2 per cent. Kohlrausch has also made comparisons of copies of the B.A. unit with standard coils, and comes to the conclusion that the B.A. unit is 1·96 per cent too large. On the other hand, Prof. Rowland, in America, has made a new determination, and finds that according to his calculations the B.A. unit is nearly 1 per cent too small. These differences in the values obtained by different methods clearly point to the necessity for one or more new determinations of the unit, and I would venture to suggest that a determination should be made under the authority of this Association, by a Committee appointed to carry out the work. And it is not sufficient that this determination should be made once for all, for there is reason to think that the resistance of standard coils alters with time, even when the material has been carefully selected. It has been found that coils o platinum silver which were correct copies of the standardf ohm have become so altered, and have their temperature coefficients so changed, that there are doubts as to the constancy of the standards themselves. Pieces of platinum silver alloy cut from the same rod have been found to have different temperature coefficients. The value 0·031 for 1° C. is given by Matthiesssen for this alloy, yet two pieces of wire drawn from the same rod have given, one 0·021 per cent, and the other 0·04 per cent for 1° C. Possibly this irregularity in the platinum-silver alloys may be due to something analogous to the segregation which Mr. Roberts has found to take place in copper-silver alloys in their molten state, and which Matthiessen in 1860 regarded as mechanical mixtures of allotropic modifications of the alloy.

A recommendation has been made that apparatus for determining the ohm should be set up in London, and that periodically determinations be made to test the electrical constancy of the metals and alloys used in making coils. A committee should be authorised to test coils and issue certificates of their accuracy, just as is done by the Kew Committee with regard to meteorological instruments. The direct relation between heat and chemical work has been established, and the principles of conservation of energy been shown to be true in chemistry by the

experiments of Berthelot and of Thomsen, so that we may say that when a system of bodies passes through any succession of chemical changes, the heat evolved or absorbed when no external mechanical effect is produced depends solely upon the initial and final states of the system of bodies, whatever be the nature or the order of the transformations. The extension of this principle to the interaction of the molecules and atoms of bodies on one another is of vast importance in relation to our knowledge of the constitution of matter, for it enables us to state that each chemical compound has a distinct level or potential which may be called its own, and that when a compound gives up one of its elements to another body, the heat evolved in the reaction is the difference between the heat of formation of the first compound, and that of the resulting product.

We have become accustomed to regard matter as made up of molecules, and those molecules to be made up of atoms separated from one another by distances which are great in comparison with the size of the atom, which we may regard as the smallest piece of matter that we can have any conception of. Each atom is surrounded by an envelope of ether which accompanies it in all its movements. The density of the ether increases rapidly as an atom is approached, and it would seem that there must be some force of attraction between the atom and its ether envelope. All the atoms have motions of translations in all possible directions, and according to the theories of Maxwell and Boltzmann, and the experiments of Kundt, Warburg, and others on the specific heat of vapour, in one-atom molecules in the gaseous state there is no motion of rotation. According to the theory of Pictet, the liquid state being the first condensation from the gaseous state must consist of at least two gaseous atoms combined. These two atoms are bound to one another through their ether envelopes. Then the solid state results from the condensation of a liquid, and so a solid molecule must consist of at least two liquid molecules, *i.e.*, at least four gaseous molecules, each surrounded by an atmosphere of ether. M. Pictet imagines these atoms to be centres of attraction; hence in the solid with four such centres the least displacement brings into action couples tending to prevent the molecule from hoisting as soon as external forces act upon it. All the molecules constituting a solid will be rigidly set with regard to one another, for the least displacement sets in action a couple or an opposing force in the molecules on one another.

Let us now follow the sketch which M. Pictet has given of changes which we may consider it to undergo when we expend energy upon it. Suppose a solid body is at absolute zero of temperature, which may be regarded as the state in which the molecules of a body are in stable equilibrium and at rest, the application of heat gives a vibratory motion to the molecules of the solid, which increases with the temperature, the mean amplitude of vibration being a measure of the temperature. We may regard the sum of all the molecular forces as the specific heat of the body, and the product of the sum of all the molecular forces by the mean amplitude of the oscillations; *i.e.*, the product of the specific heat and the temperature will be the quantity of heat or the energy of motion of the body. As more and more heat is applied, the amplitude of vibration of the molecules increases until it is too great for the molecular forces, or forces of cohesion, and the melting-point of the solid is reached. Besides their vibratory motion, the molecules are now capable of motions of translation from place to place among one another. To reduce the solid to the liquid state, *i.e.*, to make the amplitude of vibration of the molecules sufficient to prevent them from coming within the sphere of the forces of cohesion, requires a quantity of heat which does not appear as temperature or molecular motion, and hence it is termed the latent heat of fusion. The temperature remains constant until the melting is complete, the heat being spent in bursting the bonds of the solid. Then a further application of heat increases the amplitude of vibration, or raises the temperature of the liquid at a rate depending on its specific heat until the succession of blows of the molecules overcomes the external pressure and the boiling-point is reached. An additional quantity of heat is applied, which is spent in changing the body to a gas, *i.e.*, to a state of higher potential, in which the motion of translation of the molecules is enormously increased. When this state is attained, the temperature of the gas again begins to increase, as heat is applied, until we arrive at a certain point, when dissociation begins, and the molecules of the separate substances of which the body is composed have so large an amplitude of vibration that the bond which unites them can no longer bring them again into their former positions. The potential of the substances is again raised by a quantity which is proportional to its chemical affinity. Again, we may increase the amplitude of vibration, *i.e.*, the temperature of the molecules, and imagine the possibility of getting higher and higher degrees of dissociation.

If temperature means the amplitude of vibration of the molecules, then only those bodies which have their temperatures increased by the same amount when equal amounts of heat are applied to them can possibly combine with one another; and so the fact that the increase of temperature bears a fixed ratio to the increase of heat may be the cause in virtue of which bodies can combine with one another. Were other bodies to begin to combine together at any definite temperature, they would immediately be torn to pieces again when the temperature is even slightly raised, because the amplitudes of vibration of their molecules no longer remain the same. This idea of temperature is supported by the fact that a combining molecule of each substance requires the same amount of heat to raise its temperature by the same number of degrees, the atomic weights being proportional to the masses of the combining molecules. The celebrated discovery of Faraday, that in a voltameter the work done by an electric current always decomposes equivalent quantities of different substances, combined with the fact that in the whole range of the physical forces work done is equivalent to the application of heat, is quite in accordance with the view that no molecule can combine with another which has not its amplitude of vibration altered by the same amount when equal quantities of heat are applied to both. As soon as we get any divergence from this state of equal motions for equal increments of heat, then we should expect that a further dissociation of molecules would take place, and that only those which are capable of moving together can remain still associated. Just as in the change of state of a body from the solid to the liquid, or from the liquid to the gas, a great amount of heat is spent in increasing the motion of translation of the molecules without altering the temperature, so a great amount of heat is spent in producing dissociation without increasing the temperature of the dissociated substances, since the principle of conservation of energy has been shown by M. Berthelot to hold for the dissociation of bodies. We may conveniently make use of the term latent heat of dissociation for the heat required to dissociate a unit of mass of a substance.

We may thus sum up the laws of physical and chemical changes:—

1. All the physical phenomena of change of state consist in the subdivision of the body into molecules or particles identical with one another.

2. The re-constitution of a body into a liquid or a solid being independent of the relative position of the molecules, only depends on the pressure and temperature.

3. Dissociation separates bodies into their elements, which are of different kinds, and the temperature remains constant during dissociation.

4. The reunion of dissociated bodies depends on the relative position of the elements, and so depends on the grouping of the molecules. The atomic weight being the mass of a molecule as compared with hydrogen, the specific volume, *i.e.*, the atomic weight divided by

the density, is the volume or *mean free path* of a molecule.

Building up his theory of heat on these principles, M. Pictet arrives at a definite relation between the atomic weight of a body, its density, its melting-point, and its co-efficient of expansion, which may be stated thus—

The volume of a solid body will be increased as the temperature rises by an amount which is proportional to the number of the molecules in it, and inversely as its specific heat. At a certain temperature peculiar to each body, the amplitude of heat oscillation is sufficient to melt the solid, and we are led to admit that for all bodies the intermolecular distance corresponding to fusion ought to be the same. The higher the point of fusion of a body the shorter, on this theory, must be its heat vibrations. The product of the length of *swing* (the heat oscillations) by the temperature of fusion ought to be a constant number for all solid bodies.

A comparison of the values of the various quantities involved in these statements shows a very satisfactory agreement between theory and experiment, from which it appears that for many different substances the product of the length of swing by the temperature of fusion lies between 3·3 and 3·7 for most substances. Not many values of the latent heat of dissociation have been made. In order to determine it, say, for the separation of oxygen and hydrogen, we should have to determine the amount of work required to produce a spark in a mixture of oxygen and hydrogen, and to measure the exact amount of water or vapour of water combined by the spark as well as the range of temperature through which it had passed after its formation.

Our usual mode of producing heat is by the combination of the molecules of different substances, and we are limited in the production of high temperatures, and in the quantity of available heat necessary to dissociate any considerable quantity of matter. If we heat vapours or gases, we may raise their temperature up to a point corresponding to the dissociation of their molecules, and we are limited in our chemical actions to the temperatures which can be obtained by combining together the most refractory substances, as we are dependent on this combination for our supply of heat.

The combination of carbon and hydrogen with oxygen will give us high temperatures, so that by the oxyhydrogen blowpipe most of the salts and oxides are dissociated. The metalloids bromine, iodine, sulphur, potassium, &c., are the results of the combination of two or more bodies bound together by internal forces much stronger than the affinity of hydrogen or carbon for oxygen, for approximately they obey the law of Dulong and Petit.

For higher temperatures, in order to dissociate the most refractory substances, we require the electric current, either a continuous current, as in the electric arc from a battery or a dynamo-machine, or, more intense still, the electrical discharges from an electrical machine or from an induction coil.

This electric current may be regarded as the most intense furnace for dissociating large quantities of the most refractory substances, and the electric spark may be regarded as something very much hotter than the oxyhydrogen blowpipe, and therefore of service in reducing very small quantities of substances which will yield to no other treatment. The temperature of the electric arc is limited, and cannot reach above the temperature of dissociation of the conductor, and in the case of the constant current, which will not leap across the smallest space of air unless the carbons have first been brought in contact, the current very soon ceases when the point of fusion has been reached. Yet in the centre of the arc we have the gases of those substances which form the conductor; and, as Professor Dewar has shown, we have the formation of acetyline and cyanogen and other compounds, and therefore must have attained the temperature necessary for their formation, *i.e.*, the temperature of their dissociation. The temperature of the induction spark, or, at least, its dissociating power, is higher than that of the arc. We know that the spark will pass across a space of air or a gaseous conductor, and we are limited by the dissociation of the gaseous conductor, and get only very small quantities of the dissociated substances, which immediately re-combine, unless they are separated. If the gases formed are of different densities they will diffuse at different rates through a porous diaphragm, and so may be obtained separated from one another. As the molecules of bodies vibrate they produce vibrations of the ether particles, the period of the oscillations depends on the molecules of the body, and these periodic vibrations are taken up by their ether envelopes and by the luminiferous ether, and their wave-length determined by means of the spectroscope. The bright line spectrum may be regarded as arising from the vibratory motions of the atoms. As the temperature is increased, the amplitudes of oscillation of the molecules and of the ether increase, and from the calculations of Lecoq de Boisbaudran, Stoney, Soret, and others, it would appear that many of the lines in the spectra of bodies may be regarded as harmonics of a fundamental vibration. Thus Lecoq de Boisbaudran finds that in the nitrogen spectrum the blue lines seen at a high temperature correspond to the double octave of certain vibrations, and that, at a lower temperature, red and yellow lines are seen which correspond to a fifth of the same fundamental vibrations.

The bright line spectrum may be regarded as arising from the vibratory motions of the atoms. A widening of the lines may be produced at a higher temperature by the backward and forward motions of the molecules in the direction of the observer. A widening of the lines may also be produced by increase of pressure, because it diminishes the free path of the molecules, and the disturbances of the ether arising from collisions becomes more important than vibrations arising from the regular vibrations of the atoms. Band spectra, or channelled space spectra, more readily occur in the case of bodies which are not very readily subject to chemical actions, or, according to Professors Liveing and Dewar, in the case of cooler vapours near the point of liquefaction.

The effects of change of temperature on the character of spectra is very well illustrated by an experiment of M. Wiedemann with mixtures of mercury with hydrogen or nitrogen in a Geissler's tube. At the ordinary temperature of the air the spectrum of hydrogen or nitrogen was obtained alone; but on heating the tube in an air-bath the lines of mercury appeared and became brighter as the temperature rose, and at the same time the hydrogen lines disappeared in the wider portion of the tube and at the electrodes. The hydrogen or nitrogen lines disappeared first from the positive electrodes and in the luminous tuft, and as the temperature rose disappeared altogether. With nitrogen in a particular experiment, up to 100° C., the nitrogen lines were seen throughout the tube, but from 100° to 230° the nitrogen lines appear towards the negative pole, and the mercury lines are less bright at the negative than at the positive pole, while about 230° C. no nitrogen lines appear. The experiments of Roscoe and Schuster, of Lockyer, and other observers, with potassium, sodium, and other metalloids in vacuum tubes, from which hydrogen is pumped by a Sprengel pump, also show great changes in the molecular condition of the mixture contained in the tubes when they are heated to different temperatures. The changes of colour in the tube are accompanied by changes in the spectrum. Thus Lockyer finds that when potassium is placed in the bottom of the tube, and the spark passes in the upper part of it, as the exhaustion proceeds and the tube is slightly heated, the hydrogen lines disappear, and the red potassium line makes its appearance; then, as the temperature is increased, the red line disappears, and three lines in the yellowish green make their appearance, accompanied by a change in the colour of the tube, and at a higher temperature, and with a Leyden jar joined to a secondary circuit of the induction coil, the gas in the tube becomes of a dull red colour, and with this change a strong line comes out

in the spectrum, more refrangible than the usual red potassium line. In this case, on varying the conditions, we get a variation in the character of the spectrum, and the colours and spectra are different in different parts of the tube. In Lockyer's experiments, at the temperature of the arc obtained from a Siemens dynamo-machine, great differences appear in different parts of the arc: for instance, with carbon poles in the presence of calcium, the band spectrum of carbon, or the carbon flutings and the lines of calcium, some of them reversed, are seen separated in the same way as mercury and hydrogen, the carbon spectrum appearing near one pole and the calcium near the other, the lines which are strongest near that pole being reversed or absorbed by the quantity of calcium vapour surrounding it. On introducing a metal into the arc, lines appear which are of different intensities at different distances from the poles, others are strong at one pole and entirely absent at or near the other, while some lines appear as broad as half-spindles in the middle of the arc, but are not present near the poles. Thus, the blue line of calcium is visible alone at one pole, the H and K lines without the blue line at the other.

We may probably regard these effects as the result, not of temperature alone, but must take into account that we have powerful electric currents which will act unequally on the molecules of different bodies according as they are more or less electro-positive. It would seem that we have here something analogous to the segregation which is observed in the melting of certain alloys to which I have already referred.

The abundance of material in some parts of the arc surrounding the central portion of it gives rise to reversal of the principal lines in varying thicknesses over the arc and poles, so that bright lines appear without reversal in some regions, and reversals or absorption lines without bright lines in others. The introduction of a substance into the arc gives rise to a flame of great complexity with regard to colour and concentric envelopes, and the spectra of these flames differ in different parts of the arc. Thus, in a photograph of the flame given by manganese, the line at wave-length 4234·5 occurs without the triplet near 4030, while in another the triplet is present without the line 4234·5.

The lines which are reversed most readily in the arc are generally those the absorption of which is most developed in the flame; thus the manganese triplet in the violet is reversed in the flame, and the blue calcium line is often seen widened when the H and K lines of calcium are not seen at all. In consequence of the numerous changes in spectra at different temperatures, Mr. Lockyer has advanced the idea that the molecules of elementary matter are continually being more and more broken up as their temperature is increased, and has put forward the hypothesis that the chemical elements with which we are acquainted are not simple bodies, but are themselves compounds of some other more simple substances. This theory is founded on Mr. Lockyer's comparisons of spectra and the maps of Angstrom, Thalèn, Young, and others, in which there are coincidences of many of the short lines of the spectra of different substances. These short lines are termed basic lines, since they appear to be common to two or more substances. They appear at the highest temperatures when the longest lines of those substances and those which are considered the test of their presence are entirely absent.

Mr. Lockyer draws a distinction between weak lines, which are basic, *i.e.*, which would permanently exist at a higher temperature in a more elementary stage, and other weak or short lines which would be more strongly present at a lower temperature, in a more complex stage of the molecules. Thus, in lithium, the red line is a low temperature line, and the yellow is feeble; at a higher temperature, the red line is weak, the yellow comes out more strongly, and the blue line appears; at a higher temperature still, the red line disappears, and the yellow dies away; whilst at the temperature of the sun the violet lithium line is the only one which comes out strongly. These effects are studied by first producing the spectrum of the substance in the Bunsen flames, and observing the changes which are produced on passing a spark through the flame; thus, in magnesium a wide triplet, or set of three lines (5209·8, b^1 and b^2), is changed with a narrow triplet (b^1, b^2, and b^4) of the same character. We have here what some observers regard as a recurrence of the same harmonic relation of the vibrations of the same body at a higher temperature.

If the so-called elements are compounds, they must have been formed at a very high temperature, and as higher and higher temperatures are reached the dissociation of these compound bodies will be effected, and the new line spectra, the real basic lines of those substances which show coincidences, will make their appearance as short lines in the spectra. In accordance with this view, Mr. Lockyer holds that the different layers of the solar atmosphere may be regarded as a series of furnaces, on the hottest of which, A, we have the most elementary forms of matter capable of existing only in its uncombined state; at a higher and cooler level, B, this form of matter may form a compound body, and may no longer exist in a free state at the lower temperature: as the cooler and cooler levels, C, D, and E, are reached, the substances become more and more complex and form different combinations, and their spectra become altered at every stage. Since the successive layers are not at rest, but in a state of disturbance, we may get them somewhat mixed, and the lines at the cooler levels, D and E, may be associated with the lines of the hotter levels; these would be basic or coincident lines in the spectra of two different compounds which exist at the cooler levels D and E. We might even get lines which are not present in the hottest furnace, A, coming into existence as the lines of compounds in B and C, and then extending among the lines belonging to more complex compounds which can only exist at a lower temperature, when they might be present as coincident weak lines in the spectra of several compound bodies. Thus Mr. Lockyer regards the calcium lines H and K of the solar spectrum as evidence of different molecular groupings of more elementary bodies. In the electric arc with a weak current the single line 4226 of calcium, which is easily reversed, is much thicker than the two lines H and K; but the three lines are equally thick with a stronger current, and are all reversed. With a spark from a large coil, and using a condenser, the line 4226 disappears, and H and K are strong lines. In the sun the absorption bands H and K are very broad, but the band 4226 is weak. Prof. Young, in his observation of the lines of the chromosphere, finds that H and K are strongly reversed in every important spot and in solar storms; but the line 4226, so prominent in the arc, was only observed three times in the chromosphere.

One of the most interesting features among the most recent researches in Spectrum Analysis is the existence of rhythm in the spectra of bodies, as has been shown by M. Mascart, Cornu, and others, such as the occurrence and repetition of sets of lines, doublets, and triplets in the spectra of different substances and in different parts of the spectrum of the same body. Professors Liveing and Dewar, using the reversed lines in some cases for the more accurate determination of wave-lengths, have traced out the rhythmical character in the spectra of sodium, potassium, and lithium. They show that the lines of sodium and potassium form groups of four lines each, which recur in a regular sequence, while lithium gives single lines, which, including the green line, which they show really to belong to lithium, though it was ascribed to cæsium by Thalèn, also recur in a similar way. In these three metals the law of recurrence seems to be the same, but the wave-lengths show that the whole series are not simple harmonies of one fundamental, although between some of the terms very simple harmonic relations can be found. Between the lines G and H are two triplets of iron lines. which, according to Mr. Lockyer, do not belong to the same

molecular grouping as most of the other lines. In many photographs of the iron spectrum these triplets have appeared almost alone. Also the two triplets are not always in the same relation as to brightness, the more refrangible being barely visible with the spark. Combining this with Young's observations, in which some short weak lines near G appear in the chromosphere 30 times, while one of the lines of the less refrangible triplet only appears once, and with the fact that in the solar spectrum the more refrangible triplet is much the more prominent of the two, Mr. Lockyer is led to the conclusion that these two triplets are again due to two distinct molecular groupings. There is one difficulty which must be taken account of in connec- with Mr. Lockyer's theory with regard to the production of successive stages of dissociation by means at our command:—(1) By combustion of different substances; (2) by an electric arc, which will probably give slightly different temperatures according as it is produced by different dynamo-electric machines; (3) by the induction spark without; and (4) with a condenser.

At each stage of the process there must be a considerable absorption of heat to produce the change of state, and our supply of heat is limited in the electric arc because of the dissociation of the conductors, and more limited still in quantity in the electric spark or in the discharge through a vacuum tube; also, we should expect a recombination of the dissociated substances immediately after they have been first dissociated. Hence it seems easier to suppose that at temperatures which we can command on the earth, the dissociation of molecules by the arc or spark is accompanied by the formation of new compounds, in the formation of which heat and light, and especially chemical vibrations, would be again given out, giving rise to new spectra, rather than to suppose that we can reach the temperatures necessary for successive stages of dissociation.

To the lines C, F, the line near G, and *h* belonging to hydrogen, which have a certain rhythmical character, Mr. Lockyer adds D_3 and Kirchoff's line "1474," regarding "1474" as belonging to the coolest or most complex form, and rising to F, which is again subdivided into C and G, using the spark without a condenser, which again gives *h* with the spark and condenser, which is again split up and gives D_3, a more simple line than *h*, in the chromosphere. Professors Liveing and Dewar, on the other hand, trace a rhythmical character or ratio between three of the brightest lines of the chromosphere, two of which are lines "1474" and "*f*" of Lorenzoni, similar to the character of C, F, and *h* of hydrogen, and also trace a similar relation between the chromospheric line D_3 and "1474" to the ratio of the wave-lengths of F and the line near G. They infer the probability that these four lines are due to the same at present unknown substance as had been suggested by Young with regard to two of them.

The harmony of this arrangement is somewhat disturbed by the fact that D_3 lies on the wrong side of "1474" to correspond with the line near G of the hydrogen spectrum.

If we enquire what our sun and the stars have to say to these changes of spectra of the same substance at different temperatures, Dr. Huggins gives us the answer.

In the stars which give a very *white* light, such as Sirius or α Lyræ, we have the lines G and *h* of hydrogen and also H, which has been shown by Dr. Vogel to be coincident with a line of hydrogen; but the K line of calcium is weak in α Lyræ, and does not appear in Sirius. In passing from the white or hottest stars to the yellow stars like our sun, the typical lines diminish in breadth and are better defined, and K becomes stronger relatively to H, and other lines appear. In Arcturus we have a star which is probably cooler than our sun, and in it the line K is stronger in relation to H than it is in the solar spectrum, both being very strong compared with their state in the solar spectrum.

Professors Liveing and Dewar find that K is more easily reversed than H in the electric arc, which agrees with the idea that this line is produced at a lower temperature than H.

Besides the absence or weakness of K, the white stars have twelve strong lines winged at the edges, in which there are three of hydrogen, viz., G, *h*, and H, and the remaining nine form a group which are so related to one another that Dr. Huggins concludes they probably belong to one substance. Three of these lines are said by Dr. Vogel to be lines of hydrogen.

Liveing and Dewar have made considerable progress in determining the conditions and the order of reversal of the spectral lines of metallic vapours. They have adopted methods which allow them to observe through greater thicknesses of vapour than previous observers have generally employed. For lower temperatures tubes of iron or other material placed vertically in a furnace were used, and the hot bottom of the tube was the source of light, the absorption being produced by vapours of metals dropped into the hot tube and filling it to a greater or less height. By this means many of the more volatile metals—such as sodium, thallium, iridium, cæsium, and rubidium, magnesium, lithium, barium, strontium, and calcium—each gave a reversal of its most characteristic line or pair of lines, *i.e.*, the red line of lithium, the violet lines of rubidium and calcium, the blue line of strontium, the sharp green line of barium (5535), and no other lines which can certainly be ascribed to those metals in the elementary state.

For higher temperatures tubes bored out in blocks of lime or of gas carbon, and heated by the electric arc, were used. By keeping up a supply of metal, and in some cases assisting its volatilisation by the admixture of a more volatile metal, such as magnesium, and its reduction by some easily oxidisable metal, such as aluminium, or by a current of coal-gas or hydrogen, they succeeded in maintaining a stream of vapour through the tube so as to reverse a great many lines. In this way the greater part of the bright lines of the metals of the alkalies and alkaline earths were reversed, as well as some of the strongest lines of manganese, aluminium, zinc, cadmium, silver, copper, bismuth, and the two characteristic lines of iridium and of gallium. By passing an iron wire into the arc through a perforated carbon electrode they succeeded in obtaining the reversal of many of the lines of iron. In observing bright line spectra they have found that the arc produced by a De Meriten's machine arranged for high tension gives, in an atmosphere of hydrogen, the lines C and F, although the arc of a powerful Siemens machine does not bring them out, and they have observed many metallic lines in the arc which had not been previously noticed. The temperature obtained by the De Meritens machine is thus higher than that obtained in the Siemens machine.

From observations on weighed quantities of sodium, alone and as an amalgam, introduced into a hot bottle of platinum filled with nitrogen, of which the pressure was varied by an air-pump, they conclude that the width of the sodium lines depends rather on the thickness and temperature of the vapour than upon the whole quantity of sodium present. Very minute quantities diffused into the cool part of the tube give a broad diffuse absorption, while a thin layer of compressed vapour in the hot part of the tube gives only narrow absorption lines. Professors Liveing and Dewar have observed the reversal of some of the well-known bands of the oxides and chlorides of the alkaline earth metals. The lines produced by magnesium in hydrogen form a rhythmical series extending all across the well-known B group, having a close resemblance in general character to the series of lines produced by an electric discharge in a vacuum tube of olefiant gas. The series appears at all temperatures except when a large condenser is employed along with the induction coil, provided hydrogen is present as well as magnesium, while they disappear when hydrogen is excluded, and never appear in dry nitrogen or carbonic oxide.

From their experiments on carbon spectra they conclude with Angstrom and Thalén that certain of the so-called "carbon bands" are due to some compound of carbon with hydrogen, probably acetylene, and that certain others are

due to a compound of carbon with nitrogen, probably cyanogen.

They describe some ultra-violet bands: one of them coincides with the shaded band P of the solar spectrum which accompanies the other violet bands in the flame of cyanogen, as well as in the arc and spark between carbon electrodes in the nitrogen. All the bands which they ascribe to a compound of carbon and nitrogen disappear when the discharge is fallen in a non-nitrogenous gas, and they reappear on the introduction of a minute quantity of nitrogen. They appear in the flame of hydrocyanic acid, or of cyanogen, even when cooled down as much as possible, as shown by Watts, or when raised to the highest temperature by burning the cyanogen in nitric oxide; but no flames appear to give these bands unless the burning substance contains nitrogen already united with carbon.

As the views of Mr. Lockyer with regard to the multiple spectra of carbon have very recently appeared in the pages of *Nature*, I need only say that these spectra are looked upon as supporting his theory that the different flutings are truly due to carbon, and that they represent the vibrations of different molecular groupings. The matter is one of very great interest as regards the spectra of comets, for the bands ascribed to acetylene occur in the spectra of comets without the bands of nitrogen, showing that either hydrocarbons must exist ready formed in the comets, in which case the temperature need not exceed that of an ordinary flame, or else nitrogen must be absent, as the temperature which would produce acetylene from its elements would also produce cyanogen, if nitrogen were present.

Quite recently Professors Liveing and Dewar have, simultaneously with Dr. Huggins, described an ultra-violet emission spectrum of water, and have given maps of this spectrum. It is not a little remarkable that by independent methods these observers should have deduced the same numbers for the wave-lengths of the two strong lines at the most refrangible end of this spectrum.

Great attention has been paid by M. Mascart and by M. Cornu to the ultra-violet end of the solar spectrum. M. Mascart was able to fix lines in the solar spectrum as far as line R (3179), but was stopped by the faintness of the photographic impression. Professor Cornu has extended the spectrum still farther to the limit (2948), beyond which no further effect is produced, owing to complete absorption by the earth's atmosphere. A quartz-reflecting prism was used instead of a heliostat. The curvature of the quartz lens was calculated so as to give minimum aberration for a large field of view. The Iceland spar prism was very carefully cut. A lens of quartz was employed to focus the sun on the slit. Having photographed as far as possible by direct solar light, Professor Cornu compared the solar spectrum directly by means of a fluorescent eyepiece with the spectrum of iron, and then obtained, by photographing, the exact positions of the iron lines which were coincident with observed lines in the solar spectrum. M. Cornu states that the dark absorption lines in the sun and the bright iron lines of the same refrangibility are of the same relative importance or intensity in their spectra, indicating the quality between the emissive and the absorbing powers of metallic vapours; and he thinks that we may get by the comparison of bright spectra with the Sun some rough approximation to the quantity of metallic vapours present in the absorption layers of the sun's atmosphere. He draws attention to the abundance of the magnetic metals—iron, nickel, and magnesium—and to the fact that these substances form the composition of most meteorites. M. Cornu has studied the extent of the ultra-violet end of the spectrum, and finds that it is more extended in winter than in summer, and that, at different elevations, the gain in length of the spectrum for increase of elevation is very slow on account of atmospheric absorption, so that we cannot hope greatly to extend the spectrum by taking elevated observing stations. The limit of the solar spectrum is reached very rapidly, and the spectrum is sharply and completely cut off at about the line U (wave-length 2948). From photographs taken at Viesch in the valley of the Rhone and at the Riffelberg, 1910 metres above it, M. Cornu finds the limits to be at wave-lengths 2950 and 2930 respectively.

In the actual absorption of bright line spectra by the earth's atmosphere, M. Cornu observed among others three bright lines of aluminium, which M. Soret calls 30, 31, and 32 (wave-lengths about 1988, 1930, and 1860), and he found that 32 could not be seen at the distance of 6 metres; but on using a collimator, and reducing the distance to 1½ metres, the line 32 became visible, notwithstanding the absorption of the extra lens; at 1 metre, line 32 was brighter than 31, and at a quarter of a metre 32 was brighter than either 30 or 31. With a tube 4 metres in length between the collimator and prism ray 32 is not seen; but when the tube is exhausted, ray 31 gains in intensity and 32 comes into view, and gradually gets brighter than 31, whilst 30 changes very little during the exhaustion. With the same tube he found no appreciable difference between the absorption by air very carefully dried and by moist air, and concludes that this absorption is not due to the vapour of water, and it follows the law of pressure of the atmosphere, which shows it to be due to the whole mass or thickness of the air. Also, M. Soret has shown that water acts very differently on the two ends of the spectrum, distilled water being perfectly transparent for the most refrangible rays, since a column of water of 116 c.m. allowed the ray 2060 in the spectrum of zinc to pass through: on the other hand, water is so opaque to the ultra-red rays that a length of 1 c.m. of it reduces the heat-spectra of metals to half their length and one-quarter of their intensity.

In concluding my address I wish to draw attention to some of those magnetic changes which are due to the action of the sun, and which are brought about by means of the ether which brings us his radiant heat and light. In his discussion of the magnetic effects observed on the earth's surface, General Sabine has shown the existence of diurnal variations due to the magnetic action of the sun; also the magnetic disturbances, aurora and earth currents, which are now again beginning to be large and frequent, have been set down to disturbances in the sun.

Although iron, when raised to incandescence, has its power of attracting a magnet very greatly diminished, we have no proof that it has absolutely no magnetic power left, and with a slight magnetic action the quantity of iron in the sun would be sufficient to account for the diurnal variations of the magnetic needle. During the last few weeks I have been engaged in examining the declination curves for the month of March, 1879, which have been kindly lent to the Kew Committee by the Directors of the Observatories of St. Petersburg, Vienna, Lisbon, Coimbra, and Stonyhurst. On comparing them with the Kew curves for the same period, I find the most remarkable coincidences between the curves from these widely distant stations. It was previously known that there was a similarity between disturbances at different stations, and in one or two cases a comparison between Lisbon and Kew had been made many years ago by Senor Capello and Professor Balfour Stewart, but the actual photographic magnetic records from several stations have never been previously collected, and so the opportunity for such comparisons had not arisen. Allow me in concluding my address to draw attention to a few of the more prominent features of these comparisons which I have made. On placing the declination curves over one another, I find that in many cases there is absolute agreement between them, so that the rate of change of magnetic disturbances at widely distant stations like Kew, Vienna, and St. Petersburg is precisely the same; also, similar disturbances take place at different stations at the same absolute time. It may be stated generally, for large as well as small disturbances, that the east and west deflections of the declination needle take place at the same time and are of the same character at these widely different stations.

There are exceptions to this law. Some disturbances occur at one or two stations and are not perceived at

another station. Many instances occur where, up to a certain point of time, the disturbances at all the stations are precisely alike, but suddenly at one or two stations the disturbance changes its character. For instance: on comparing Kew and St. Petersburg, we get perfect similarity followed by deflections of the needle opposite ways at the same instant, and in some such cases the maxima in opposite directions are reached at the same instant, showing that the opposite deflections are produced by the same cause, and that the immediate cause or medium of disturbance in such a case is not far off: probably it is some change of direction or intensity of the earth's magnetism arising from solar action upon it.

Generally, after an hour or two, these differences in the effects of the disturbance vanish, and the disturbances again become alike and simultaneous. In such cases of difference, if the curve tracing of the horizontal or the vertical force be examined, it is generally found that, at the very instant of absolute time, with the beginning of these opposite movements there was an increase or a diminution in the horizontal force, and that the horizontal force continues to change as long as there is any difference in the character of the declination curves. It is clear, then, from these effects that the cause or causes of magnetic disturbances are in general far distant from the earth's surface, even when those disturbances are large; but that not unfrequently these causes act on magnetic matter nearer to the surface of the earth, and therefore at times between two places of observation, and nearer to one than another, thus producing opposite effects on the declination needle at those places: in such cases the differences are probably due to changes in the earth's magnetic force. Now, if we imagine the masses of iron, nickel, and magnesium in the sun to retain even a slight degree of magnetic power in their gaseous state—and we know from the researches of Faraday that gases are some of them magnetic—we have a sufficient cause for all our terrestrial magnetic changes, for we know that these masses of metal are ever boiling up from the lower and hotter levels of the sun's atmosphere to the cooler upper regions, where they must again form clouds to throw out their light and heat, and to absorb the light and heat coming from the hotter lower regions; then they become condensed, and are drawn again back towards the body of the sun, so forming those remarkable dark spaces or sun spots by their downrush towards the lower levels.

In these vast changes, which we know from the science of energy must be taking place, but of the vastness of which we can have no conception, we have abundant cause for these magnetic changes which we observe at the same instant at distant points on the surface of the earth, and the same cause acting by induction on the magnetic matter within and on the earth may well produce changes in the magnitude or in the direction of its total magnetic force. These magnetic changes on the earth will influence the declination needles at different places, and will cause them to be deflected: the direction of the deflection must depend on the situation of the earth's magnetic axis or the direction of its motion with regard to the stations where the observations are made. Thus both directly and indirectly we may find in the sun not only the cause of diurnal magnetic variations, but also the cause of these remarkable magnetic changes and disturbance over the surface of the earth.

NOTE ON SILVER SULPHATE.*

PHILIP BRAHAM, F.C.S.

The silver sulphate was shown as brilliant transparent crystals of high refractive power. They were produced by pouring on a plate of pure silver strong sulphuric acid and adding a few drops of strong nitric acid. At first there was a slight action, bubbles of gas being liberated. In a day or two the whole of the sulphuric acid acquired a deep purple tint, probably due to the formation of some oxide of nitrogen. After a lapse of two to three weeks the purple tint sinks towards the silver and a slight brown tint can be seen on the surface. The layer above the silver being colourless, about this period long crystals form, which re-dissolve, and the liquid becomes colourless. In the course of a few days brilliant specks are seen, which develop into perfect crystals of a regular octahedral shape. The crystals shown had taken over six months in growing.

* A paper read before the Chemical Section of the British Association, Swansea Meeting, 1880.

THE ANALYSIS OF A CRYSTALLINE SALT, PREPARED BY THE ACTION OF H_2SO_4 WITH A TRACE OF HNO_3 ON METALLIC MERCURY ACTING IN THE COLD.*

By PHILIP BRAHAM, F.C.S.

The action whereby these crystals were produced was a very slow one, extending over two years. The crystals were in the form of rhombic prisms, and remained transparent only as long as they were covered with the most concentrated sulphuric acid, an instant of exposure to the air or exposure for a few hours under the acid changed them into an amorphous white powder. The crystals were so remarkably deliquescent that after being freed from acid and dried at 100° C., they absorbed over 5 per cent of their own weight of moisture in five minutes, so that it became almost impossible to be certain of the real weight of a sample. As the crystals were found to be attacked by carbon disulphide, ether, and amyl-alcohol, they were dried and freed from acid by absorption with asbestos. Carbonate of soda and potassic hydrate both produced black precipitates (containing traces of red or yellow) when boiled with the salt showing the presence of a *mercurous* salt containing small quantities of mercuric.

A quantitative determination of the acid made by boiling a weighed amount with solution of sodic carbonate and precipitating as barium sulphate gave the following results:—2·02 grains yielded in one experiment 1·8 $BaSO_4$=0·62 of SO_3 or 30·7 per cent of SO_3. In another experiment—12·63 grains yielded 11·06 of $BaSO_4$=3·8 of SO_3=30 per cent SO_3. The mercury was estimated by reduction with HCl and $SnCl_2$, washing the precipitated metal and drying at 100° C.

(1.) Salt taken 6·07 grains: Hg found 3·81 = 63 per cent = Hg_2O 65·52 per cent.

(2.) Salt taken 11·48 grains: Hg found 8·05 = 70 per cent = 72·8 Hg_2O.

In this case the salt had been left exposed under the acid for some hours, and had become partially changed, so that in drying on asbestos it readily broke up, the actual analysis being performed on the less changed parts of the substance.

The salt is thus certainly *a mercurous sulphate*, but, as normal mercurous sulphate, Hg_2SO_4, contains 80·64 per cent of mercury, and as the highest percentage found, even in the partially changed salt, was 70 per cent, whilst the lowest was 63, and this from a sample which had certainly absorbed a little water in weighing, it appears certain that the salt, whilst still unchanged under the acid in which it was formed, consists of mercurous bisulphate, $HgHSO_4$, which contains 67·3 per cent of Hg, and 27 per cent of SO_3. The excess of SO_3 found (3 per cent) arises from two causes.

(1.) The difficulty of weighing without absorption of water and consequent decomposition.

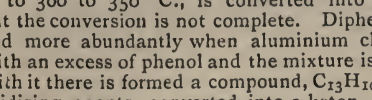
(2.) The difficulty of perfectly freeing from H_2SO_4 without decomposing it entirely.

* A paper read before the Chemical Section of the British Association, Swansea Meeting, 1880.

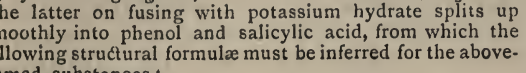
ETHERIFICATION OF PHENOLS.

At the meeting of the Zurich Chemical Society, held on July 19th, Professor Weith communicated the results of a research on the etherification of phenols, which he and Professor Merz had undertaken along with their demonstrator, Dr. Iuvalta.

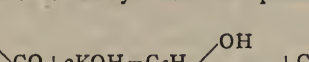
It is already known that phenol, on heating with zinc chloride to 300 to 350° C., is converted into diphenyl oxide, but the conversion is not complete. Diphenyl oxide is formed more abundantly when aluminium chloride is mixed with an excess of phenol and the mixture is distilled. Along with it there is formed a compound, $C_{13}H_{10}O$, which is, by oxidising agents, converted into a keton, $C_{13}H_8O_2$. The latter on fusing with potassium hydrate splits up smoothly into phenol and salicylic acid, from which the following structural formulæ must be inferred for the above-named substances:—



The formation of salicylic acid is represented by the equation:—



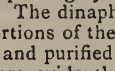
Much easier than the etherification of ordinary phenol is that of the two isomeric naphthols, especially that of the β compound. As proved by the giving off of water, it takes place already on passing hydrogen chloride through the boiling naphthols. The dinaphthyl ethers are freed from any unchanged portions of the original substance by a solution of an alkali, and purified by distillation and recrystallisation. They are evidently formed according to the equation:—



The β-dinaphthyl oxide crystallises most easily from petroleum spirit in white laminæ with a mother-of-pearl or silvery lustre, abundantly soluble in hot alcohol, petroleum spirit, and glacial acetic acid, but only sparingly so in the cold liquids. Their melting-point is 105° C.

The α-dinaphthyl ether crystallises from hot spirit of wine in small, colourless, rhombic plates; from petroleum spirit similar but thicker crystals are obtained, sometimes looking like rhombohedra. The solubilities of the α-compound are similar to those of the β-dinaphthyl ether. It melts at 110° C.

In the preparation of the α-dinaphthyl ether there is always obtained a substance which appears in needles, united in tufts, and is undoubtedly identical with a dinaphthylene oxide—



prepared by Mr. Unzeitig in the laboratory of Professor Graebe, at Geneva, by distilling the lead compound of α-naphthol. The melting-point was found at 182 to 182·5°C., whilst Unzeitig states 180°; the compound was quite colourless from the first. The same dinaphthylene oxide is formed along with an acid compound of high boiling-point, where α-naphthol is boiled very persistently in a capacious retort fitted with a reflux cooler.

Under similar circumstances β-naphthol yields considerable quantities of β-dinaphthylene oxide, $\beta(C_{10}H_6)_2O$, which crystallises, when quite pure, from benzene or from a mixture of benzene and spirits of wine in thoroughly white laminæ of a strong silvery lustre, melting at 161° C. The two dinaphthylene oxides are only sparingly soluble even in boiling spirit of wine, but abundantly in boiling benzene, and they are most easily crystallised by adding hot spirit of wine to their hot solution in benzene.

Similar to the naphthylene oxides also their picric acid compounds melt at a higher temperature than those of the dinaphthyl ethers, viz., the picrate of α-dinaphthylene oxide at 173°, that of the β-compound at 170° to 171°, that of α-dinaphthyl oxide at 113·5° to 114°, of β-oxide at 122° to 122·5°.

CORRESPONDENCE.

A REPLY TO DR. LEEDS.

To the Editor of the Chemical News.

Sir,—In his paper printed in the Chemical News, vol. xlii., p. 147, Dr. Leeds has again referred to the production of ozone by the atmospheric oxidation of phosphorus, and has particularly called attention to the part I have taken in the controversy.

I like the enthusiastic and earnest spirit in which Dr. Leeds writes of the older chemists and their researches, but, strictly speaking, he is not quite accurate in his statement that I pronounced the doctrines of Schönbein to be false. I simply raised some doubts as to the entire correctness of these views, which were expressed at a time when the means of deciding the questions involved were by no means so ample or as certain as they have since become. Moreover, my objections were not of the theoretical character Dr. Leeds would seem to imply, since my own investigations led me to assert that (apart from the oxidation of phosphorus, which was the subject under discussion) "there is no known process of slow oxidation which has been established to produce ozone."

The severity of Dr. Leeds's assertion, in reply, made me resolve to investigate the oxidation of phosphorus for myself, and having done so I find that although the doubts raised by me are not justified by the results, yet Schönbein did not arrive at a complete knowledge of the process, neither did Dr. Leeds. In fact, my results go a little further, and I have discovered a few new points which on continued investigation are calculated to throw still more light upon a field of chemistry so successfully cultivated by Schönbein.

A discussion of this sort, conducted in a kindly spirit and with the utmost regard to ascertained facts, is not calculated to obstruct the progress of chemical science. To take the present case in illustration of this, my paper published in the Chemical News, vol. xl., p. 96, induced Professor McLeod to enter this "particular arena of controversy," and led both Dr. Leeds and myself to study the subject concerned unknown to each other, and the result is that Schönbein's fame comes out, if anything, all the brighter for the cloud of controversy, and the sum of chemical knowledge is increased. Progress is made in this way. With these few remarks I may let the matter rest until I make my report to the Chemical Society next November.
—I am, &c.,

C. T. Kingzett.

September 18, 1880.

Cause of the Acid Reaction of Animal Tissues after Death.—Marie Ekunina.—The acid reaction is due to a decomposition of the fluids in the tissues effected immediately after death by the action of Schizomycetes. At first volatile fatty acids appear derived from the incipient decomposition of the albumen, speedily followed by the two lactic acids produced from glycogen. The richer a tissue in carbohydrates, the longer this acid reaction prevails after death, as in the liver, the muscles, and the lungs. It is briefest and faintest in the pancreas. In the later hours of putrefaction, the lactic acids disappear and are succeeded by succinic acid. Sooner or later an alkaline reaction sets in throughout the tissues, much ammonia being evolved from the decomposition of the albumen.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 5, August 2, 1880.

The Optical Properties of Mixtures of Isomorphous Salts.—H. Dufet.—The author has verified the law which he communicated to the Academy, April 8, 1878, *i.e.*, that a crystal formed of a mixture of two isomorphous salts has indices of refraction, which vary continuously with its composition, so that the variation in the value of the index is proportional to the number of equivalents of one of the salts introduced into the mixture.

Influence of Temperature on the Distribution of Salts in their Solutions.—C. Soret.—In all the salts which the author has studied the concentration of the heated portion decreases and that of the cold part increases. The difference thus established increases with the orginal concentration. In the series of the alkaline chlorides the difference is so much the greater for the same absolute concentration as the molecular weight is higher. The phenomenon seems to have no relation with the curve of solubility.

Rise of the Zero-point in Mercurial Thermometers.—J. M. Crafts.—The zero-point rises further and more quickly in thermometers of "crystal" glass than in those free from lead. The rise of the zero-point is much more rapid at the outset, and tends probably towards a limit for a very prolonged heating at a fixed temperature. The effect of an elevated temperature renders the thermometer more stable under the influence of heat at any lower temperature.

Development by Pressure of Polar Electricity in Hemihedral Crystals with Inclined Surfaces.—MM. Jacques and Pierre Curie.—Whatever may be the determining cause, whenever a hemihedral non-conducting crystal with inclined surfaces, there is a formation of electric poles in a certain direction; whenever the crystal expands the disengagement of electricity takes place in an opposite direction.

Moniteur Scientifique, Quesneville. April, 1880.

Report on a Memoir of MM. Boutmy and Faucher on the Industrial Preparation of Dynamite.—The authors recommend randannite, a siliceous mineral found abundantly in Auvergne, as a substitute for kieselguhr.

Action of Permanganate upon Potassium Cyanide.—E. Baudrimont.—This reaction produces much nitrite and a little urea in an alkaline medium, whilst, if the liquid is acidified with sulphuric acid, urea is formed in abundance. The simultaneous formation of two incompatible compounds, urea and nitrous acid, under the influence of permanganate, shows that the nitrogen of the cyanogen is exposed at once to an oxidising action and to hydrogenisation.

Comparative Solubility of Lead Phosphate and Arseniate in Dilute Acetic Acid.—Armand Bertrand.—One part of lead arseniate dissolves in 2703·05 parts of dilute acetic acid at 38·94 per cent. One part of lead phosphate requires only 782·90 parts of the same acid.

Solubility of Recently Precipitated Carbonate of Lime in Ammoniacal Salts in Presence of an Equivalent Proportion of Sodium Chloride.—Armand Bertrand.—At the temperature of 10° to dissolve 1 grm. calcium carbonate there are required:—

Ammonium hydrochlorate	13·980 grms.
„ sulphate	8·380 „
„ nitrate..	14·438 „

June, 1880.

Virulent Diseases, and in particular on the Malady commonly known as Poultry-Cholera.—M. Pasteur.—From the *Comptes Rendus.*

Review of Chemical Researches Published in Germany.—A. Kopp.—A series of extracts from the *Berichte der Deutsch. Chem. Gesellschaft.*

Composition of Cinchonine.—Z. H. Skraup.—Already noticed.

Products of the Oxidation of Cinchonine.—Z. H. Skraup.—From *Liebig's Annalen*, for June, 1879.

Contribution to the Knowledge of Cinchonidine.—Z. H. Skraup and G. Vortmann.—From *Liebig's Annalen.*

Falsification of Alimentary Substances.—An abstract of the German laws on the adulteration of food, the local arrangements for putting them in force, and the results obtained.

Industrial Society of Mulhouse.—*Session April* 14.—A letter from Dr. Reimann on the subject of dyeing silica, together with accompanying specimens, was laid before the meeting. Precipitated silica is dyed as fast and more easily than infusorial tubes, and here capillarity does not intervene.

A sealed paper from the firm of Scheurer-Rott, opened at the last session, refers to an improvement in alizarin steam reds, by printing upon pieces previously prepared with emulsive oil, mixed in certain cases with hypochlorite of soda. For producing cadmium sulphide directly upon the fibre, M. Schmid prints a mixture of arsenious acid, sulphur, sodium acetate, and cadmium nitrate. A fine yellow is obtained by steaming for 1 to 2 hours and an orange is produced by increasing the sodium acetate.

Session May 12.—A sealed paper by the firm of Hofer-Grosjean was opened, referring to improvements in dissolving caseine. Equal parts of caseine and lime are recommended.

A sealed paper by the firm of Poirrier was opened, relating to the production of fast blues by the reaction of aldehyd upon the violets of methyl and methylaniline.

A paper by M. Ziegler was opened, recommending an addition of arsenic or boracic acid to the colour beck in dyeing madder reds and roses.

Toxicology.—An Italian commision, including among its members Prof. Selmi, is examining the methods for the detection of poisonous alkaloids in the viscera, with especial reference to the so called "ptomaines,"—alkaloids which under certain circumstances may be generated during the putrescence of animal matter.

Celluloid.—An account of the manufacture of this product.

July, 1880.

German Law on the Falsification of Alimentary Substances.—Continued from the June number, and not capable of useful abstraction.

Manufacture of Factitious Butter in the United States.—A compilation from American and English sources. Factitious butter contains only 1·823 per cent of butyrine, caprine, caproine, and capryline, as against 7·432 per cent in the natural product.

Manufacture of Vinegar by means of Bacteria.—E. Wurm.—A translation from *Dingler's Polyt. Journal* (1880, p. 325). The process followed is that described by M. Pasteur in 1868, in his *Etudes sur le Vinaigre.*

Non-existence of Mercury in the Mineral Water of the Source "Du Rocher" at Saint Nectaire.—Jules Lefort.—The nature of this paper will appear sufficiently from the title.

Contributions to the Study of Quinamine.—A. C. Oudemans, Junr.—From *Liebig's Annalen.*

Products of the Decomposition of Quinine.—Dr. M. W. Ramsay and J. J. Dobbie.

Note on Safranine.—R. S. Dale and C. Schorlemmer, F.R.S.

Mauveine and its Kindred Colouring Matters.—W. H. Perkin, F.R.S.—The three above papers are from the *Journal of the Chemical Society*.

On Aspidospermine.—Georg Fraude.—From the *Beriehte der Deutsch. Chem. Gesellschaft*.

Oil of Sheep's Feet.—Th. Chateau.—The author maintains that this oil is much superior to horse-foot oil and neat's-foot oil with which it is generally confounded in commerce. When pure it is of a very pale yellow colour, and weighs 0·915 grm. per litre.

Purification and Refining of Fatty Matters.—Octave Allaire.—To recognise if an oil is pure, the author takes a piece of carbonate of soda (crystal), the size of a nut, dissolves it in its own bulk of water, and shakes it up with the oil under examination in a bottle. If the oil becomes turbid, and gives on settling a solid bulky deposit, it has been badly purified. Oils which act upon the metal of lamps and form deposits of verdigris are also to be rejected as impure. Commercial samples often contain 10 to 15 per cent of free oleic acid.

Bulletin de la Société Chimique de Paris, No. 9, May 5, 1880.

Remarks on the Platinum Sulphocyanide of V. Marcagno.—G. Wyrouboff.—This body is not a platinum sulphocyanide, but a potassium platino-sulphocyanide, having in its anhydrous state been long ago analysed by M. Buckton. Nor does it yield a proof of the octo-atomicity of platinum, which in this case, as in many others, is tetratomic.

A Compound of Titanium Tetrachloride and Acetyle Chloride.—Armand Bertrand.—On mixing these two bodies the compound in question is immediately precipitated in small yellow brilliant spangles resembling lead iodide. On exposure to moisture these crystals undergo a change, liberating hydrochloric acid. They may be preserved in dry air, or preferably in dry hydrochloric acid. They melt at 25° to 30° and crystallise on cooling. In contact with alkaline solutions they are decomposed, forming an alkaline acetate and chloride, titanic acid which is precipitated, and water. The analysis of the crystals yielded results agreeing with the formula $C_2H_3OCl+TiCl_4$.

Certain Properties of Mixtures of Methyl Cyanide with Common Alcohol and Methylic Alcohol.—C. Vincent and B. Delachanal.—In order to separate methyl cyanide from alcohol it is necessary to submit the mixture to fractionated distillation to order to classify the products; then to dissolve the largest possible quantity of calcium chloride in the mixture, boiling at the lowest temperature in order to absorb the alcohol; then to distil again in the water-bath, and to submit again the product thus obtained to fractionated distillation. A very rich cyanide is thus obtained, from which the last traces of alcohol are eliminated by distillation over a small quantity of phosphoric anhydride, and by rectification to remove the small quantity of ethyl oxide and acetate which take rise from the reaction of the phosphoric acid.

Determination of Urea by Sodium Hypobromite.—C. Mehu.—The author criticises the memoirs of M. Fauconnier and M. Jay (*Bulletin de la Soc. Chimique*, xxxiii., pp. 102 and 105). In opposition to the former of these chemists he finds that the presence of cane-sugar distinctly augments the quantity of nitrogen evolved from urea by means of sodium hypobromite. In opposition to M. Jay he considers that it is easy to meet with starch syrups, which give off merely an insignificant quantity of ammonia if heated with caustic soda.

Oxalic Acid.—A. Villiers.—Already noticed.

Electrolysis of Malonic Acid.—Edme Bourgoin.—Malonic acid presents the following characters:—In the free state it is very stable as against the current, and becomes concentrated in the positive compartment,—a two-fold character by which it is removed from its lower homologue, oxalic acid. In a concentrated alkaline solution it does not in any case give rise to a hydrogen carbide,—which distinguishes it from succinic acid.

Aceto-benzoic Anhydride.—W. H. Greene.—The differences which M. Loir conceives he has observed between acetyle benzoate and benzoyl acetate do not exist. These are one and the same body, whose constitution is the same whatever is its mode of formation, and whose reactions under the same conditions are identical.

Constitution of the Salts of Rosaniline and of Analogous Colouring-Matters (Second Memoir).—A. Rosenstiehl.—If rosaniline is a triamidic aromatic carbinol its salts will be of two classes: the first series is to be regarded as the ether of a tertiary aromatic alcohol; the second series comprises the salts of this ether, which is itself a triacid amine.

Resin of Palisander Wood.—A. Terreil and A. Wolff.—The authors ascribe to this resin the composition—$C_{21}H_{21}O_8$. It is very soluble in alcohol in all proportions, less soluble in ether, chloroform, and carbon disulphide, and insoluble in water. Nitric acid transforms it into an acid, which crystallises in very fine orange-yellow needles, united in tufts.

MISCELLANEOUS.

Schools of Chemistry, &c.—The following information was received too late for insertion in our Students' Number:—

Science and Art Department, South Kensington.—*Examinations, May*, 1881.—Inorganic Chemistry: Friday, 20th; 7 to 10 p.m. Practical Inorganic Chemistry: Saturday, 21st; Elementary Stage, 7 to 10 p.m.; Advanced Stage, 6 to 10 p.m.; Honours, 2 to 10 p.m. Organic Chemistry: Friday, 27th; 7 to 10 p.m. Practical Organic Chemistry: Saturday, 28th; Elementary Stage, 7 to 10 p.m.; Advanced Stage, 6 to 10 p.m.; Honours, 2 to 10 p.m. (Analysis Tables and works on Chemistry may be used in the Advanced Stage and Honours Examinations). Examinations in Practical Chemistry can only be held in Laboratories complying with the requirements of the Science Directory. Each candidate must have a separate set of apparatus and reagents. No examination in Practical Chemistry will be held at South Kensington.

Bedford College, 8 and 9, York Place, Portman Square, for Ladies only.—Chemical Lecturer—Thomas Eltoft, F.C.S., F.I.C. *Matriculation Examination*.—This course will consist of about 35 lectures, so arranged as to cover the whole of the work for the above examination. After each lecture, the student will do practical work. Lectures commence October 16. *First B.Sc. Examination*.—This course will consist of about 40 lectures. Practical Chemistry following each lecture. Lectures and Laboratory work, Wednesdays and Saturdays, throughout the session. For terms, see special prospectus, which can be obtained on application to the Secretary, Henrietta Le Breton.

Royal Agricultural College, Cirencester.—Lecturer, Dr. E. W. Prevost, F.C.S., F.R.S.E.

Queenwood College, Hants.—Lectures on Inorganic Chemistry and Physics, and Laboratory Classes. Resident Lecturer, Dr. H. Wilson Hake, F.C.S., F.I.C.

Peculiar Reaction of Stannous Chloride with Potassium Chlorate.—If 2 parts of stannous chloride and 1 part of potassium chlorate, both finely powdered, are ground together in a porcelain mortar, the mass becomes very hot, gives off watery vapour and chlorous acid, whilst the yellowish white residue, if dissolved in boiling water, deposits, on cooling, potassium perchlorate in splendid micaceous crystals. The mother-liquor contains potassium chlorate and tin oxychloride.—*Polytech. Notizblatt.*

THE CHEMICAL NEWS.

Vol. XLII. No. 1088.

ADDRESS TO THE GEOLOGICAL SECTION OF THE BRITISH ASSOCIATION.

By H. CLIFTON SORBY, LL.D., F.R.S., F.G.S.,
President of the Section.

In selecting a subject for an address to be given in accordance with the custom of my predecessors, I was anxious that it should be, in some way or other, connected with the locality in which we have met. If I had been adequately acquainted with the district I should have thought it incumbent on me to give such an outline of the general geology of the surrounding country as would have been useful to those attending this meeting. I am, however, practically a stranger to South Wales, and must therefore leave that task to others. On reflecting on the various subjects to which I might have called your attention, it appeared to me that I could select one which would be eminently appropriate in a town and district where iron and copper are smelted on so large a scale, and, as I think, also equally appropriate from a geological point of view. This subject is the comparative structure of artificial slags and erupted rocks. In making this choice I was also influenced by the fact that in my two anniversary addresses as President of the Geological Society I have recently treated on the structure and origin of modern and ancient stratified rocks, and I felt that, if in the present address I were to treat on certain peculiarities in the structure of igneous rocks, I should have described the leading conclusions to which I have been led by studying the microscopical structure of nearly all classes of rocks. It would, however, be impossible in the time now at disposal to treat on all the various branches of the subject. Much might be said on both the purely chemical and purely mineralogical aspects of the question; but though these must not be ignored, I propose to draw your attention mainly to another special and remarkable class of facts, which, so far as I am aware, have attracted little or no attention, and yet, as I think, would be very instructive if we could fully understand their meaning. Here, however, as in so many cases, the observed facts are clear enough, but their full significance somewhat obscure, owing to the want of adequate experimental data or sufficient knowledge of general physical laws.

A considerable amount of attention has already been paid to the mineral constitution of slags, and to such peculiarities of structure as can be learned independently of thin microscopical sections. A very complete and instructive work, specially devoted to the subject, was published by Von Leonhard about twenty-two years ago, just at the time when the microscope was first efficiently applied to the study of rocks. Since then Vogelsang and others have described the microscopical structure of some slags in connexion with their studies of obsidian and other allied volcanic rocks. At the date of the publication of Von Leonhard's work the questions in discussion differed materially from those which should now claim attention. There was still more or less dispute respecting the nature and origin of certain rocks which have now been proved to be truly volcanic by most unequivocal evidence; and I am not at all surprised at this, since, as I shall show, there is such a very great difference in their characteristic structure and that of the artificial products of igneous fusion, that, but for the small portions of glass inclosed in the constituent crystals, described by me many years ago under the name of "glass cavities," there would often be no positive proof of their igneous origin. There was also considerable doubt as to the manner in which certain minerals in volcanic rocks had been generated. The observed facts were sufficient to prove conclusively that some had been formed by sublimation, others by igneous fusion, and others deposited from more or less highly heated water; but it was difficult or impossible to decide whether in particular cases certain minerals had been formed exclusively by one or other process, or sometimes by one and sometimes by the other, or by the combined action of water and a very high temperature. I must confess that, even now that so much may be learned by studying with high magnifying powers the internal structure of crystals, I should hesitate very much in deciding what were the exact conditions under which certain minerals have been formed. This hesitation is probably as much due to inadequate examination and to the want of a complete study of typical specimens, both in the field and by means of the microscope, as to the unavoidable difficulties of the subject. Such doubt, however, applies more to the origin of minerals occurring in cavities than to those constituting a part of true rock masses, to which latter I shall almost exclusively refer on the present occasion. In the formation of these it appears to me that sublimation has occurred to a very limited extent. In many cases true igneous fusion has played such a leading part that the rocks may be fairly called *igneous*, but in other cases, water, in some form or other, has, I think, had so much influence that we should hesitate to call them *igneous*, and the term *erupted* would be open to far less objection, since it would adequately express the manner of their occurrence, and not commit us to anything open to serious doubt.

In studying erupted rocks of different characters, we see that at one extreme they are as truly igneous as any furnace product, and, at the other extreme, hardly, if at all, distinguishable from certain deposits met with in mineral veins, which furnish abundant evidence of the preponderating, if not exclusive, influence of water, and have very little or nothing in common with products certainly known to have been formed by the action of heat, and of heat alone. Between these extremes there is every connecting link, and in certain cases it is almost, if not quite, impossible to say whether the characteristic structure is due more to the action of heat than of water. The great question is whether the presence of a small quantity of water in the liquid or gaseous state is the true cause of very well-marked differences in structure; or whether greater pressure, and the necessarily slower rate of cooling, were not the more active causes, and the presence of water in one state or another was merely the result of the same cause. This is a question which ought to be solved by experiment; but I fear it would be almost impossible to perform the necessary operations in a satisfactory manner.

What I now propose to do is to describe a particular class of facts which have lately attracted my attention, and to show that the crystalline minerals in products known to have been formed by the action of heat alone have a certain very well-marked and characteristic structure, which is gradually modified as we pass through modern and more ancient volcanic to plutonic rocks, in such a manner as to show at once that they are intimately related, and yet differ in such characteristic particulars that I think other agencies than mere heat must have had great influence in producing the final result.

In dealing with this subject I propose, in the first place, to describe the characteristic structure of products formed artificially under perfectly well-known conditions, and then to pass gradually to that of rocks whose origin must be inferred, and cannot be said to have been completely proved.

Crystalline Blowpipe Beads.

Some years ago I devoted a considerable amount of time to the preparation and study of crystalline blowpipe beads, my aim being to discover simple and satisfactory means for identifying small quantities of different earths

and metallic oxides, when mixed with others; and I never supposed that small objects would throw any light on the structure and origin of vast masses of natural rock. The manner in which I prepared them was as follows:—A small bead of borax was so saturated with the substance under examination at a high temperature that it became opaque either on cooling or when slowly re-heated. It was again fused so as to be quite transparent, and then very slowly cooled over the flame. If properly managed, the excess of material held in solution at a high temperature slowly crystallised out, the form and character of the crystals depending on the nature of the substance and on the presence of other substances added to the bead as test reagents. By this means I proved that in a few exceptional cases small simple solid crystals are formed. More frequently they are compound, or occur as minute needles; but the most characteristic peculiarity is the development of complex skeleton crystals of extreme beauty, built up of minute attached prisms, so as to give rise to what would be a well-developed crystal with definite external planes, if the interspaces were all filled up. In many cases the fibres of these skeletons are parallel to three different axes perpendicular to one another, and it might be supposed that the entire skeleton was due to the growth of small needle-shaped crystals all uniformly elongated in the line of one crystalline axis, so that the resulting mass would be optically and crystographically complex; but in some cases the different systems of fibres or needles are inclined obliquely, and then the optical characters enable us to prove that the separate prisms are not similar to one another, but developed along different crystalline planes, so as to build up one definite crystal, mechanically complex, but optically and crystographically simple, or merely twinned. In a few special cases there is a well-pronounced departure from this rule, and truly compound groups of prisms are formed. In the centre, that is a definite simple prism; but instead of this growing continuously in the same manner, so as to produce a larger prism, its ends, as it were, break up into several smaller prisms, slightly inclined to the axis of the first; and these secondary prisms, in like manner, break up into still smaller, so as ultimately to give rise to a curious complex brush-like growth, showing in all positions a sort of fan-shaped structure, mechanically, optically, and crystographically complex.

I have done my best to describe these various kinds of crystals seen in blowpipe beads as clearly as can be done without occupying too much time, but feel that it is impossible to make the subject as simple as it really is without numerous illustrations. However, for the purpose now in view, it will, I trust, suffice to have established the fact that we may divide the crystals in blowpipe beads into the following groups, which on the whole are sufficiently distinct, though they necessarily pass one into the other.

1. Simple crystals.
2. Minute detached needles.
3. Fan-shaped compound groups.
4. Feathery skeleton crystals.

It must not be supposed that crystals of one or other of these groups occur promiscuously and without some definite relation to the special conditions of the case. Very much depends upon their chemical composition. Some substances yield almost exclusively those of one group, and other substances those of another, whilst in some cases a difference in the rate of cooling and other circumstances give rise to variations within certain limits; and, if it were possible to still further vary some of the conditions, these limits would probably be increased. Thus, for example, the earliest deposition of crystalline matter from the glassy solvent is sometimes in the form of simple solid prisms or needles, but later on in the process it is in the form of compound feathery tufts; and if it were possible to cool the beads much more slowly whilst they are very hot, I am inclined to believe that some substances might be found that in the early stage of the process would yield larger and more solid crystals than those commonly met with. This supposition, at all events, agrees with what takes place when such salts as potassium chloride are crystallised from solution in water. Some of my blowpipe beads prove most conclusively that several perfectly distinct crystalline substances may be contemporaneously deposited from a highly heated vitreous solvent, which is an important fact in connection with the structure of igneous rocks, since some authors have asserted that more than one mineral species cannot be formed by the slow cooling of a truly melted rock. The great advantage of studying artificial blowpipe beads is that we can so easily obtain a variety of results under conditions which are perfectly well known, and more or less completely under control.

Artificial Slags.

I now proceed to consider the structure of slags, and feel tempted to enter into the consideration of the various minerals found in them which are more or less perfectly identical with those characteristic of erupted rocks; but some of the most interesting, like the felspars, occur in a well-marked form only in special cases where iron ores are smelted with fluxes, seldom, if ever, employed in our own country, so that my acquaintance with them is extremely small. My attention has been mainly directed to the more common products of our blast-furnaces. On examining these, after having become perfectly familiar with the structure of blowpipe beads, I could see at once that they are very analogous, if not identical, in their structure. In both we have a glassy solvent, from which crystals have been deposited; only in one case this solvent was red hot, melted borax, and in the other glassy, melted stone. Thus, for example, some compounds, like what I believe is Humboldtilite, crystallise out in well-marked solid crystals, like those seen occasionally in blowpipe beads, whereas others crystallise out in complex feathery skeletons, just like those so common in and characteristic of the beads. In both we also often see small detached needles, scattered about in the glassy base. These skeleton crystals and minute needles have been described by various writers under the names *crystallites*, *belonites*, and *trichites*. Though we have not the great variety of different forms met with in the beads, and cannot so readily vary the conditions under which they are produced, yet we can, at all events, see clearly that their structural character depends both on their chemical constitution and on the physical conditions under which they have crystallised. None of my microscopical preparations of English slags appear to contain any species of felspar, but several contain what I believe is some variety of angite, both in the form of more or less solid prisms, and of feathery skeletons of great beauty and of much interest in connection with the next class of products to which I shall call your attention, viz., rocks artificially melted and slowly cooled.

Rocks Artificially Melted.

I have had the opportunity of preparing excellent thin microscopical sections of some of the results of the classic experiments of Sir James Hall. I have also carefully studied the product obtained by fusing and slowly cooling much larger masses of the basalt of Rowley, and have compared its structure with that of the original rock. Both are entirely crystalline, and, as far as I can ascertain, both are mainly composed of the same minerals. Those to which I would especially call attention are a triclinic felspar and the angite. The general character of the crystals is, however, strikingly different. In the artificial product a considerable part of the angite occurs as flat feathery plates, like those in furnace slags, which are quite absent from the natural rock, and only part occurs as simple solid crystals, analogous to those in the rock, but much smaller and less developed. The felspar is chiefly in the form of elongated, flat, twinned prisms, which, like the prisms in some blowpipe beads, commence in a more simple form and end in complex fan-shaped brushes, whereas in the

natural rock they are larger than in the artificial, and exclusively of simple character. On the whole, then, though the artificially melted and slowly cooled basalt is entirely crystalline, and has a mineral composition closely like that of the natural rock, its mechanical structure is very different, being identical with that of blowpipe beads and slags.

Volcanic Rocks.

Passing now to true natural igneous rocks, we find some, like obsidian, which closely correspond with blowpipe beads, slags, and artificially melted rocks, in having a glassy base, through which small crystalline needles are scattered; but the more completely crystalline volcanic rocks have, on the whole, a structure very characteristically unlike that of the artificial products. I have most carefully examined all my sections of modern and ancient volcanic rocks, but cannot find any in which the angite or magnetite is crystallised in feathery skeletons. In the case of only one single natural rock, from a dyke near Beaumaris, have I found the triclinic felspar arranged in just the same fan-shaped, brush-like groups as those in similar rocks artificially melted and slowly cooled. The large solid crystals in specimens from other localities sometimes show that towards the end of their growth small flat prisms were developed on their surface, analogous to those first deposited in the case of the artificial product. In slags composed almost exclusively of what I believe is Humboldtilite, the crystals are indeed uniformly as simple and solid as those in natural rocks, but the examination of different blowpipe beads shows that no fair comparison can be made between altogether different substances. We must compare together the minerals common to the natural and the artificial products, and we then see that, on the whole, the two classes are only just distinctly connected by certain exceptional crystyls and by structural characters which, as it were, overlap enough to show that there is a passage from one type to the other. In the artificial products are a few small solid crystals of both angite and a triclinic felspar, which closely correspond to the exceptionally small crystals in the natural rocks; but the development of the great mass of the crystals is in a different direction in the two cases. In the artificial products it is in the direction of complex skeletons, which are not seen in the natural rock; but in the natural rock it is in the direction of large simple solid crystals, which are not met with in the artificial products. There is a far closer analogy in the case of partially vitreous rocks, which, independent of the true glassy base common to them and the artificial products, often contain analogous crystalline needles. Even then, however, we see that in the artificial product the crystals tend to develop into complex skeletons, but in the natural rocks into simple solid crystals.

It must not be supposed that these facts in any way lead me to think that thoroughly crystalline modern and ancient volcanic rocks were never truly fused. The simple, large, and characteristic crystals of such minerals as angite, felspar, leucite, and olivine, often contain so many thoroughly well-marked glass enclosures, as to prove most conclusively that when the crystals were formed they were surrounded by, and deposited from, a melted glassy base, which was caught up by them whilst it was still melted. This included glass has often remained unchanged, even when the main mass became completely crystalline, or has been greatly altered by the subsequent action of water. I contend that these glass enclosures prove that many of our British erupted rocks were of as truly igneous origin as any lava flowing from a modern volcano. The difference between the structure of such natural rocks and that of artificial slags must not, in my opinion, be attributed to the absence of true igneous fusion, but to some difference in the surrounding conditions, which was sufficient to greatly modify the final result, when the fused mass became crystalline on cooling. The observed facts are clear enough, and several plausible explanations might easily be suggested, but I do not feel at all convinced that any single one would be correct. That which first suggests itself is a much slower cooling of the natural rocks than is possible in the case of the artificial rocks; and I must confess that this explanation seems so plausible that I should not hesitate to adopt it, if certain facts could be accounted for in a satisfactory manner. Nothing could be more simple than to suppose that skeleton crystals are formed when deposition takes place in a hurried manner, and they so overgrow the supply that they develop themselves along certain lines of growth before there has been time to solidly build up what has been roughly sketched in outline. I cannot but think that this must be a true and, to some extent, active cause, even if it be inadequate to explain all the facts. What makes me hesitate to adopt it by itself is the structure of some doleritic rocks when in close contact with the strata amongst which they have been erupted. In all my specimens the effects of much more rapid cooling are perfectly well marked. The base of the rock when in close contact is sometimes so extremely fine-grained that it is scarcely crystallised, and is certainly far less crystalline and finer grained than the artificial products to which I have called attention, and yet there is no passage towards those structures which are most characteristic of slags, or at least, no such passage as I should have expected if these structures depended exclusively on more rapid cooling.

We might well ascribe something to the effect of mass, but one of my specimens of basalt melted and slowly cooled in a small crucible is quite as crystalline as another specimen taken from a far larger mass, though I must confess that what difference there is in this latter is in the direction of the structure characteristic of natural rocks. The presence or absence of water appears to me a very probable explanation of some differences. When there is evidence of its presence in a liquid state during the consolidation of a rock we can scarcely hesitate to conclude that it must have had some active influence; but in the case of true volcanic rocks the presence of liquid water is scarcely probable. That much water is present in some form or other is clearly proved by the great amount of steam given off from erupted lavas. I can scarcely believe that it exists in a liquid state, except at great depths, but it may possibly be present in a combined form or as a dissolved vapour under much less pressure, and the question is whether this water may not have considerable influence on the growth of crystals formed prior to the eruption, before it was given off as steam. I do not know one single fact which can be looked upon as fairly opposed to this supposition, and it is even to some extent supported by experiment. M. Daubrée informs me that the crystals of angite formed by him at a high temperature by the action of water have the solid character of those in volcanic rocks, and not the skeleton structure of those met with in slags. The conditions under which they were formed were, however, not sufficiently like those probably present during the formation of erupted lavas to justify our looking upon the explanation I have suggested as anything more than sufficiently plausible, in the absence of more complete experimental proofs.

Granitic Rocks.

I now proceed to consider rocks of another extreme type, which for distinction we may call the granitic. On the whole, they have little or nothing in common with slags, or with artificial products similar to slags, being composed exclusively of solid crystals, analogous in character only to slag-crystals of very different mineral nature. As an illustration, I would refer to the structure of the products formed by fusing and slowly cooling upwards of a ton of the syenite of Grooby, near Leicester. Different parts of the resulting mass differ very materially, but still there is an intimate relation between them, and a gradual passage from one to the other. The most characteristic feature of those parts which are completely crystalline is the presence of beautiful feathery skeleton crystals of magnetite, and of long flat prisms of a triclinic felspar, ending in complex, fan-shaped brushes. There

are no solid crystals of felspar, hornblende, and quartz, of which the natural rock is mainly composed, to the entire exclusion of any resembling those in the melted rock. As looked upon from the point of view taken in this address, the natural and artificial products have no structural character in common, so that I think we must look for other conditions than pure igneous fusion to explain the greatly modified results. We have not to look far for evidence of a well-marked difference in surrounding circumstances. The quartz in the natural rock contains vast numbers of fluid cavities, thus proving that water was present, either in the liquid state or as a vapour so highly compressed that it afterwards condensed into an almost equal bulk of liquid. In some specimens of granite there is indeed clear proof that the water was present as a liquid, supersaturated with alkaline chlorides, like that inclosed in the cavities of some minerals met with in blocks ejected from Vesuvius, which also have to some extent what may be called a granitic structure. In the case of one very exceptional and interesting granite, there is apparently good proof that the felspar crystallised out at a temperature above the critical point of water—that is to say, at a temperature higher than that at which water can exist as a liquid under any pressure—and it caught up highly compressed steam, comparatively, if not entirely, free from soluble salts; whereas the quartz crystallised when the temperature was so far lowered as to be below the critical point, and the water had passed into a liquid, supersaturated with alkaline chlorides, which have crystallised out as small cubes in the fluid cavities, just as in the case of minerals in some of the blocks ejected from Vesuvius.

Confining our attention, then, to extreme cases, we thus see that rocks of the granitic type differ in a most characteristic manner from the products of artificial igneous fusion, both in the structure of the crystals and in containing liquid water, inclosed at the time of their formation. The question then arises, whether these differences were due to the presence of the liquid water, or whether its presence and the characteristic structure were not both the effects of the great pressure of superincumbent rocks. I do not see how this can be decided in a perfectly satisfactory manner, but must confess that I am inclined to believe that, whilst great pressure was necessarily the reason why the water did not escape as vapour, the presence of liquid water during final consolidation must have had a very considerable influence in modifying the structure of the rock, and had a great share in developing what we may call the granitic type.

It would be very instructive to follow out the gradual passage from one extreme type to another far more completely than is possible on the present occasion. The most interesting examples of rocks intermediate between the granitic and volcanic types that I have been able to examine in adequate detail, are the various Cornish elvans and other quartz felsites, which furnish all but a complete passage from pitchstone to granite. Some specimens prove that quartz may crystallise out from and inclose a perfectly glassy base, without a trace of liquid water; and at the same time other specimens prove equally well that, as we approach the granitic type, the quartz was not deposited from a glassy solvent, but inclosed more or less water. In the few intermediate cases there appears to be evidence of the conjoint presence of uncombined water and melted stony matter. On the whole, if we take into consideration only the external form of the larger crystals, rocks of the granitic type are very much as though the crystals met with in truly volcanic rocks had been strained out from the glassy or fine-grained base, and the intermediate spaces filled with quartz. The internal structure of the crystal is, however, very different, the cavities in one class containing glass, and in the other water. This most essential and characteristic difference proves that rocks of the true granitic type cannot have been formed simply by the more complete crystallisation of the general base of the rock. If the crystals in granite were analogous to those developed in volcanic rocks, and the only essential difference were that the residue crystallised out more slowly and completely, so as to give rise to a more coarsely crystallised base, the crystals first formed ought not, as I think, to differ so essentially as that in one case they should inclose only glass, and in the other only water. Taking all into consideration, we can therefore scarcely suppose that the crystals in granitic rocks were deposited from a truly melted, dry, glassy solvent, like those in volcanic rocks or in slags.

General Results.

I have, I trust, now said enough to show that the objects here described may be conveniently separated into three well-marked groups, viz., artificial slags, volcanic rocks, and granitic rocks. My own specimens all show perfectly well-marked and characteristic structures, though they are connected in some cases by intermediate varieties. Possibly such connecting links might be more pronounced in other specimens that have not come under my notice. I must, however, base my conclusions on what I have been able to study in an adequate manner, by examining my own preparations, and leave it for others to correct any errors into which I may have been led from lack of more numerous specimens. In any case the facts seem abundantly sufficient to prove that there must be some active cause for such a common, if not general, difference in the structural character of these three different types. The supposition is so simple and attractive, that I feel very much tempted to suggest that this difference is due to the presence or absence of water as a gas or as a liquid. In the case of slags it is *not* present in *any* form. Considering how large an amount of steam is given off from eruptive lavas, and that, as a rule, no fluid-cavities occur in the constituent minerals, it appears to me very plausible to suppose that those structures which are specially characteristic of volcanic rocks are in great measure, if not entirely, due to the presence of *associated* or *dissolved vapour*. The fluid-cavities prove that water was sometimes, if not always, present as a *liquid* during the consolidation of granitic rocks; and we can scarcely hesitate to conclude that it must have had very considerable influence on the rock during consolidation. Still, though these three extreme types appear to be thus characterised by the absence of water, or by its presence in a state of vapour or liquid, I think we are scarcely in a position to say that this difference in the conditions is more than a plausible explanation of the differences in their structure. At the same time, I do not know any facts that are opposed to this conclusion, and we should, perhaps, not greatly err in thus correlating the structures, even though the water was not the essential and active cause of the differences.

Confining our attention to the more important crystalline constituents which are common to the different types, we may say that the chief structural characters of the crystals are as follows:—

a. Skeleton crystals.
b. Fan-shaped groups.
c. Glass-cavities.
d. Simple crystals.
e. Fluid-cavities.

These different structural characters are found combined in different ways in the different natural and artificial products; and for simplicity I will refer to them by means of the affixed letters.

The type of the artificial products of fusion may generally be expressed by $a+b$ or $b+c$, that is to say, it is characterised by skeleton crystals and fan-shaped groups, or by fan-shaped groups and glass cavities. In like manner the volcanic type may be expressed occasionally by $b+c$, but generally by $c+d$; and the granitic by $d+e$. These relations will be more apparent if given in the form of a table, as follows:—

Slag type	$a+b$
	$b+c$
Volcanic type	$b+c$
	$c+d$
Granitic type	$d+e$.

Hence it will be seen that there is a gradual passage from one type to the other by the disappearance of one character and the appearance of another, certain characters the meanwhile remaining common, so that there is no sudden break, but an overlapping of structural characteristics. It is, I think, satisfactory to find that, when erupted rocks are examined from such a new and independent point of view, the general conclusions to which I had been led are so completely in accord with those arrived at by other methods of study.

Conclusion.

And now I feel that it is time to conclude. I have necessarily been compelled to give only a general account of the subject, and perhaps, for want of adequate description, many facts may appear more complex than they really are. Some are, indeed, of anything but simple character, and their full explanation is, perhaps, beyond our present power. The greater part are, however, much more simple and easy to observe than to describe; and, even if I have failed to make everything as plain as I could wish, I hope I have succeeded in making the principal point sufficiently clear to show that the structure of slags and of analogous artificial products throws much light on the structure and origin of the various groups of erupted rocks. I feel that very much still remains to be learned, and, as I think, could be learned, by the further extension of this method of inquiry. What strikes me most is the great necessity for the more complete application of experimental methods of research; but to carry out the experiments necessary to clear up the essential difficulties of the subject would, I fear, be a most difficult undertaking. In the meantime all that we can do is to compare the structure of known artificial products with that of natural rocks, and to draw the best conclusions we can from the facts, as viewed in the light of our present knowledge of chemistry and physics. My own impression is that there is still much to be learned respecting the exact conditions under which some of our commonest rocks were formed.

ON A RELATION BETWEEN THE ATOMIC VOLUMES OF CERTAIN ELEMENTS AND THE HEATS OF FORMATION OF SOME OF THEIR COMPOUNDS.*

By WALTER WELDON, F.R.S.E.

When chlorine, bromine, and iodine unite with the same element in the same atomic proportions, the heat of formation of the chloride is always greater than that of the

TABLE I.

	Atomic Weights.	Atomic Volumes.	Thermal Values of Compounds.							
Mg	24·0	13·79	$MgCl_2$	151·0	$MgBr_2$	140·0	MgI_2	108·0	MgOaq	149·8
Zn	64·9	9·07	$ZnCl_2$	97·2	$ZnBr_2$	86·2	ZnI_2	60·0	ZnO	86·8
Al	27·3	10·7	Al_2Cl_6	321·8					Al_2O_3	390·0
Fe	55·9	7·2	Fe_2Cl_6	192·0					Fe_2O_3	191·2
Ag	107·66	10·28	AgCl	29·2	AgBr	22·7 / 27·7	AgI	+13·8 / +15·9		
Au	196·2	10·18	AuCl	5·8	AuBr	5·0	AuI	− 0·2		
Sr	87·2	34·88	$SrCl_2$	184·6	$SrBr_2$	168·0	SrI_2	136·0	SrO	131·0
Pb	206·4	18·15	$PbCl_2$	85·2	$PbBr_2$	77·0	PbI_2	53·2	PbO	51·2
Fe	55·9	7·2	$FeCl_2$	82·0					FeOaq	69·0
Co	58·6	6·9	$CoCl_2$	76·4					CoOaq	63·4
Ni	58·6	0·7	$NiCl_2$	74·6					NiOaq	60·8
Mg	24·0	13·79	$MgCl_2$	151·0	$MgBr_2$	140·0	MgI_2	108·0	MgOaq	149·8
Cd	111·6	12·9	$CdCl_2$	93·2	$CdBr_2$	84·2	CdI_2	55·8	CdOaq	66·4
Na	23·0	23·65	NaCl	97·7	NaBr	90·7	NaI	74·2	Na_2Oaq	135·6
Ag	107·66	10·24	AgCl	29·2	AgBr	27·7	AgI	15·9	Ag_2O	3·0

Na_2S (dis.)	103·2											
Ag_2S	3·0											

TABLE II.

	Atomic Weights.	Atomic Volumes.	Thermal Values of Compounds.									
Ag	107·66	10·22827	AgCl	29·2 / 29·4	AgBr	22·7 / 27·7	AgI	13·8 / 15·9	Ag_2O	6·0 / 7·0	Ag_2S	3·0
Hg	199·8	14·7	$\frac{Hg_2Cl_2}{2}$	40·9 / 41·3	$\frac{Hg_2Br_2}{2}$	32·1 / 39·2	$\frac{Hg_2I_2}{2}$	24·2 / 29·2	HgO	30·6	HgS	9·9
Tl	203·4	17·1	TlCl	48·6	TlBr	46·4	TlI	35·6	Tl_2O	42·2		
Li	7·02	11·9	LiCl	93·8								
Na	23·00	23·65	NaCl	97·7	NaBr	90·7	NaI	74·2	Na_2O (dis.)	135·6	Na_2S (dis.)	103·2
K	39·14	45·2	KCl	105·0	KBr	100·4	KI	85·2	K_2O (dis.)	139·6	K_2S (dis.)	112·6
Ca	39·9	25·4	$CaCl_2$	170·2	$CaBr_2$	151·6	CaI_2	118·6	CaO (dis.)	149·5	CaS	92·0
Sr	87·2	34·88	$SrCl_2$	184·6	$SrBr_2$	168·0	SrI_2	136·0	SrO (dis.)	158·2	SrS	99·2
Cu	63·3	7·0805	$CuCl_2$	51·6	$CuBr_2$	42·8			CuO	37·2	CuS	10·2
Cu_2	126·6	14·1610	Cu_2Cl_2	66·2	Cu_2Br_2	60·0	Cu_2I_2	43·8	Cu_2O	40·8		
Pb	206·4	18·153	$PbCl_2$	85·2	$PbBr_2$	77·0	PbI_2	53·8	PbO	51·4	PbS	17·8
As	74·9	13·0	$AsCl_3$	69·8 / 74·6					As_2O_3	146·0		
Sb	122·0	18·2	$SbCl_3$	86·3					Sb_2O_3	168·0		
B	11·0	4·104	BCl_3	108·5	BBr_3	73·1			$\frac{B_2O_3}{2}$	156·0		
Si	28·0	11·244	$SiCl_3$	157·6	$SiBr_3$	120·4			SiO_2	211·0		

* Read before Section B of the British Association, Swansea Meeting, August 26th, 1880.

TABLE III.

Pb	206·4	11·37	18·153	$PbCl_2$	85·2	4·693	= 1·0	$PbBr_2$	77·0	4·235 = 1·0
Cu	63·3	8·94	7·0805	Cu_2Cl_2	66·2	4·674	= 1·0	Cu_2Br_2	60·0	4·237 = 1·0
Mg	24·0	1·74	13·793	$MgCl_2$	151·0	10·939		$MgBr_2$	140·0	10·15
,,	,,	1·7	14·117	,,	151·0	10·696	= 1·5	,,	140·0	9·917 = 1·5
Zn	64·9	7·15	9·0796	$ZnCl_2$	97·2	10·708		$ZnBr_2$	86·2	9·496 = 1·5
Cd	111·6	8·65	12·907	$CdCl_2$	93·2	7·22	= 1·0	$CdBr_2$	84·2	6·523 = 1·0
Hg	199·8	13·59	14·7019	$HgCl_2$	62·8	4·268	= 1·5	Hg_2Br	60 8	4·135 = 1·5
,,	,,	,,	,,	Hg_2Cl_2	82·6	2·807	= 1·0	Hg_2Br_2	78·4	2·666 = 1·0
Ag	107·66	10·47	10·2827	AgCl	29·2	2·839	= 1·0	AgBr	27·7	2·693 = 1·0
Hg	199·8	13·59	14·7019	$\frac{Hg_2Cl_2}{2}$	41·3	2·807	= 1·0	$\frac{Hg_2Br_2}{2}$	39·2	2·666 = 1·0
Tl	203·6	11·86	17·1669	TlCl	48·6	2·831	= 1·0	TlBr	46·4	2·679 = 1·0
Au	196·2	19·26	10·1869	AuCl	5·8	0·563	= 1·0			
Ag	107·66	10·47	10·2827	AgCl	29·2	2·839	= 5·0			
Sr	87·2	2·5	34·88	$SrCl_2$	184·6	5·29	= 4·0	$SrBr_2$	168·0	4·813 = 4·0
Ca	39·9	1·57	25·414	$CaCl_2$	170·2	6·70	= 5·0	$CaBr_2$	151·6	5·972 = 5·0
Sr	87·2	2·5	34·88	$SrCl_2$	184·6	5·29	= 9·0	$SrBr_2$	168·0	4·813 = 9·0
Pb	206·4	11·37	18·153	$PbCl_2$	85·2	4·693	= 8·0	$PbBr_2$	77·0	4·235 = 8·0
Li	7·02	0·59	11·9							
Na	23·0	0·97225	23·656							
K	39·14	0·865	45·259							
Tl	203·6	11·86	17·1669							
Mn	54·8	8·019	6·8337	$MnCl_2$	112·0	16·404	= 1·5	$MnBr_2$	100·0	14·633 = 1·5
Fe	55·9	7·8	7·2	$FeCl_2$	82·0	11·38	= 1·0	$FeBr_2$	70·0	9·72 = 1·0
Co	58·6	8·5	6·9	$CoCl_2$	76·4	11·00	= 1·0			
Ni	58·6	8·8	6·7	$NiCl_2$	74·6	11·12	= 1·0			
P	31·0	2·34	13·2	PCl_3	75·8	5·74	= 1·0			
As	74·9	5·76	13·0	$AsCl_3$	74·6	5·74	= 1·0			
As	74·9	5·67	13·0	$AsCl_3$	74·6	5·65	= 6·0			
Sb	122·0	6·7	18·2	$SbCl_3$	86·3	4·73	= 5·0			
Si	28·0	2·49	11·2449	$SiCl_4$	159·2	14·01	= 7·0			
Sn	117·8	7·29	16·1	$SnCl_4$	127·2	8·00	= 4·0			
K	39·14	0·865	45·259	KCl	105·0	2·31	= 5·0	KBr	100·4	2·218 = 4·0
Na	23·0	0·97225	23·656	NaCl	97·7	4 13	= 9·0	NaBr	90·7	3·834 = 7·0
Na	23·0	0·97225	23·656							
Li	7·02	0·59	11·9							
Na	23·0	0·97225	23·656	NaCl	97·7	4·13	= 7·0	NaBr	90·7	3·834 = 7·0
Ag	107·66	10·47	10·2827	AgCl	29·2	2·83	= 5·0	AgBr	27·7	2·693 = 5·0

bromide, and the heat of formation of the bromide always greater than that of the iodide; the order of the heats of formation of the haloid compounds being thus the inverse of that of the atomic weights of the respective halogens. There is a similar relation between the heats of formation of oxides and sulphides and the atomic weights of oxygen and sulphur; the heat of formation of an oxide being always greater than that of the corresponding sulphide of the same element.

In a recent communication to the Academy of Sciences (*Comptes Rendus*, 5 Juillet, 1880), Berthelot points to certain instances in which a similar relation exists between the atomic weights of analogous positive elements and the heats of formation of their compounds, and expresses the opinion that this relation is probably general, although masked, in the cases of some families of positive elements, "*par diverses circonstances mal connues.*"

Nearly all the data bearing on this point which we at present possess are collected into the following two Tables. In both Tables, the elements bracketed together are more or less analogous elements, and are arranged in the order of their atomic weights. The order of the heats of formation of corresponding compounds, with the same negative element, of the positive elements bracketed together in Table I., is in each case the inverse of that of the atomic weights of the positive elements; but the order of the heats of formation of corresponding compounds, with the same negative element, of the positive elements bracketed together in Table II., is in all cases the same as that of the atomic weights of the positive elements. The relation between atomic weights and heats of formation of compounds which obtains in the case of chlorine, bromine, and iodine, and also in that of oxygen and sulphur, is thus exhibited by some families of positive elements, but not by others. It is therefore not of the nature of a general law.

If, however, we compare the heats of formation of corresponding compounds, with the same negative element, of positive elements of the same family, not with the atomic weights of the positive elements, but with their atomic weights divided by their specific gravities,—that is to say, with their atomic volumes,—we find what does appear to be the nature of a general law. We find that, *for corresponding compounds, with the same negative ele-*

TABLE III. (*continued*).

PbI_2	53·8	2·765=1·0	PbO	51·4	2·824=1·0						
Cu_2I_2	43·8	2·96 =1·0	Cu_2O	40·8	2·881=1·0						
ZnI_2	60·0	6·610=1·5									
CdI_2	55·8	4·223=1·0									
HgI_2	44·8	3·046=1·5	HgO	31·0	2·108=1·5					$HgCy_2$	60·16 4·18=1·5
Hg_2I_2	58·4	1·983=1·0	Hg_2O_2	42·2	1·435=1·0						
AgI_2	15·9	1·546=1·5				Ag_2S	6·0	0·29 =1·0		$AgCy_2$	27·9 =2·71=1·0
$\frac{Hg_2I_2}{2}$	29·2	1·983=2·0				HgS	18·8	1·16=4·0			
TlI	35·6	2·073=2·0									
SrI_2	136·0	3·610=4·0	SrO (dis.)	158·2	6·1 =1·5	SrS	99·2	2·842=4·0			
CaI_2	118·6	4·669=5·0	CaO (dis.)	149·5	4·52 =1·0	CaS	92·0	3·622=5·0			
SrI_2	136·0	3·610=4·0				SrS	99 2	2·842=3·0			
PbI_2	53·8	2·765=3·0				PbS	17·8	0·98 =1·0			
			LiO (dis.)	166·6	7·0 =6·0	Li_2S (dis.)	115·2	4·9 =4·0			
			Na_2O (dis.)	224·2	4·755=4·0						
			K_2O (dis.)	208·6	2·305=2·0	K_2S (dis.)	112·6	1·247=1·0			
			Tl_2O (dis.)	39·2	1·146=1·0						
MnI_2	68·0	10·14 =2·0	MnO aq	94·8	13·872=1·5	MnS	45·2	6·6 =2·0			
FeI_2	38·0	5·26 =1·0	FeO aq	69·0	9·583=1·0	FeS	23·8	3·3 =1·0			
			CoO aq	63·4	9·2 =1·0						
			NiO aq	60·8	9·1 =1·0						
			As_2O_3	146·0	5·51 =6·0						
			Sb_2O_3	168·0	4·61 =5·0						
			SiO_2	219·0	19·47 =9·0						
			SnO_2	141·2	8·434=4·0						
KI	85·2	1·882=3·0	K_2O (dis.)	208·6	2·305=1·0	K_2S (dis.)	112·6	1·247=3·0		KCy (dis.)	83·4 1·97=3·0
NaI	74·2	3·137=5·0	Na_2O (dis.)	224·2	4·755=2·0	Na_2S (dis.)	103·2	2·18 =5·0		NaCy (dis.)	78 8 3·33=5·0
			Na_2O (dis.)	224·2	4·755=1·0	Na_2S (dis.)	103·2	2·18 =3·0			
			Li_2O (dis.)	166·6	7·00 =1·5	Li_2S (dis.)	115·2	4·9 =7·0			
NaI	74·2	3·137=2·0									
AgI	15·9	1·546=1·0									

ment, of positive elements of the same family, the heats of formation are greater the greater the atomic volumes of the positive elements. This law, moreover, sometimes holds good in the case of corresponding compounds of elements belonging not to the same family, but to allied families.

In Table I. the atomic volumes of the elements bracketed together follow an order the inverse of that of the atomic weights of those elements. In Table II., for the elements bracketed together the order of the atomic volumes is the same as that of the atomic weights. While the order of the heats of formation of corresponding compounds, with the same negative element, of the positive elements bracketed together, is in the one case the inverse of, and in the other the same as, the order of the atomic weights of the positive elements, in both cases the order of the heats of formation is the same as that of the atomic volumes of the positive elements.

To this rule two exceptions may be suggested, though only two, so far as the data of thermal chemistry at present go. Both are exceptions which I believe will disappear as our knowledge of the apparently exceptional bodies becomes more complete. One of these bodies is cadmium. This metal is usually classed with magnesium and zinc, although it is known to have close resemblances also with indium. Compared with magnesium, it obeys the law. Its atomic volume is lower than that of magnesium, and the heats of formation of its compounds are lower than those of the corresponding magnesium compounds. With zinc, however, cadmium does not compare as the law would require it to do if zinc and cadmium really belonged to the same family. While the atomic volume of cadmium is greater than that of zinc, the heats of formation of cadmium compounds are lower than those of the corresponding zinc compounds. To my mind this is simply another confirmation of the view of those who class cadmium with indium rather than with zinc. If this view be sound, the heats of formation of indium compounds—none of which have yet been measured—will be found to be greater than those of cadmium compounds, the atomic volume of cadmium being 12·9, and that of indium 15·3.

The other apparently exceptional body is manganese. While the heats of formation of the compounds of manganese are greater than those of the corresponding compounds of iron, the specific gravity now usually assigned

to manganese would make its atomic volume less than that of iron. The values found for the specific gravity of manganese by different observers vary from a little over 7·0 to a little over 8·0. If the real value of the specific gravity of manganese were about the mean of these extremes, manganese—regarded as belonging to the iron family—would obey the law. Either, then, the true value of the specific gravity of manganese is somewhat lower than the value now ordinarily accepted for it; or the more intimate family relations of manganese are, not with iron, cobalt, and nickel, but with some of the other metals with which we know that it is closely allied; or else this metal really constitutes—if it be admitted that cadmium does not belong to the zinc family—the only exception to what would otherwise be, so far as the data at present go, an absolutely general law.

In all cases yet known, then, unless those of cadmium and manganese be really exceptions, the heats of formation of corresponding compounds, with the same negative element, of positive elements belonging to the same family, are greater the greater the atomic volumes of the positive elements. Having arrived at this fact, it was natural to proceed to enquire whether or not there is any strictly proportional relation between the atomic volumes of analogous positive elements and the heats of formation of their compounds. The result has been to show that in many cases the heats of formation of corresponding compounds of analogous positive elements with the same negative element are so related to the atomic volumes of the positive elements that the heats of formation, per *equal volumes* of the positive elements, are sensibly equal, and that in most other cases the heats of formation of the compounds, per unit volume (say per cubic centimetre) of their respective positive elements, exhibit a close approach to proportional relations of a very simple kind.

Take, for example, the case of lead and cuprosum. If we divide by the value of the atomic volume of Pb the values of the respective heats of formation of $PbCl_2$, $PbBr_2$, PbI_2, and PbO, and if we similarly divide by the atomic volume of Cu_2 the heats of formation of the coresponding cuprous compounds, we obtain quotients which compare together as follows:—

$PbCl_2$	4·693	= 1·0
Cu_2Cl_2	4·674	= 1·0
$PbBr_2$	4·235	= 1·0
Cu_2Br_2	4·237	= 1·0
PbI_2	2·765	= 1·0
Cu_2I_2	2·96	= 1·0
PbO	2·824	= 1·0
Cu_2O	2·881	= 1·0

We thus find that the quantity of heat liberated during the combination with Cl of a given volume of Pb, to form $PbCl_2$, and the quantity of heat liberated during combination with Cl of the same volume of copper, to form Cu_2Cl_2, are sensibly equal; and that the heats of formation, per equal volumes of the two metals, of $PbBr_2$ and Cu_2Br_2, of PbI_2 and Cu_2I_2, and of PbO and Cu_2O, respectively, are also sensibly the same.

An example of other simple proportional relations is furnished by calcium and strontium. The heats of formation of the haloid compounds of these metals, per cubic centimetre of each metal respectively, compare as follows:—

$SrCl_2$	5·29	= 4·0
$CaCl_2$	6·70	= 5·0
$SrBr_2$	4·813	= 4·0
$CaBr_2$	5·972	= 5·0
SrI_2	3·610	= 4·0
CaI_2	4·669	= 5·0

Table III. gives a large number of further examples. The second, third, and fourth columns of that Table give respectively the values employed for the atomic weights, the specific gravities, and the atomic volumes of the positive elements. In the succeeding columns the values first given after the symbols of compounds are those of their molecular heats of formation. The values next given are those of the quotients obtained by dividing the molecular heats of formation of the compounds by the atomic volumes of their positive elements. These quotients represent in each case kilogramme-calories per cubic centimetre of positive element. The numbers which follow, and which are comparable only where bracketed together, show the approximate proportions of these quotients to each other. In many cases the proportions of the quotients to each other are only approximately those of the numbers following them; but the approximations are in nearly all cases so close that, if we bear in mind that the values taken for the heats of formation cannot be regarded as being absolutely accurate, while the values taken for atomic weights and specific gravities are certainly also, in many cases, only more or less close approximations to the truth, it will be difficult to avoid the conclusion that between the quantities of heat liberated during the combination with the same negative element of equal volumes of analogous positive elements, very simple proportional relations certainly exist.

In many cases simple proportional relations are found also between the quotients obtained by dividing the molecular heats of formation of correspoding compounds of analogous positive elements with the same negative element, not by the atomic volumes of the positive elements only, but by the sums of the atomic volumes of both elements, the atomic volumes taken for the negative elements being the lowest they are known or believed to be capable of assuming in the free state. In the following examples the atomic volume of oxygen is taken at 16, in accordance with Dumas' theoretical conclusion respecting it, supposed by some to have been confirmed by the experimental results of Cailletet:—

$$\frac{MgO\ aq}{Vol.\ Mg + Vol.\ O} = 4{\cdot}98 = 1{\cdot}5$$

$$\frac{ZnO\ aq}{Vol.\ Zn + Vol.\ O} = 3{\cdot}32 = 1{\cdot}0$$

$$\frac{ZnO\ aq}{Vol.\ Zn + Vol.\ O} = 3\ 32 = 1{\cdot}5$$

$$\frac{CdO\ aq}{Vol.\ Cd + Vol.\ O} = 2{\cdot}2 = 1{\cdot}0$$

Table IV., which is to be read in the same manner as Table III., compares the heats of formation, per cubic centimetre of each positive element, of B_2O_3, SiO_2, CO_2, and P_2O_5:—

TABLE IV.

B	11·0	2 68 (1)	4·104	B_2O_3	312·6	38·05	= 2·0	= 8·0
Si	28·0	2·49 (2)	11·2449	SiO_2	219·2	19·49	= 1·0	= 4·0
C	11·9	3·519 (3)	3·42	CO_2	100·0	29 237	= 2·0	= 6·0
P	31·0	2·34 (4)	13·205	P_2O_5	363·8	14·5	= 1 0	= 3·0

(1) Amorphous B. (3) Diamond.
(2) Amorphous Si. (4) Metallic P.

This Table shows that the quantities of heat liberated during the combination with oxygen of a cubic centimetre of boron, to form boric acid, B_2O_3, is to the quantity of heat liberated during the combination with oxygen of a cubic centimetre of silicon, to form silicic acid, SiO_2, very nearly as 2 to 1; that the quantity of heat liberated during the combination with oxygen of a cubic centimetre of carbon, as diamond, to form CO_2, is to the quantity of heat liberated during the combination with oxygen of a cubic centimetre of crystallised phosphorus, to form P_2O_5, also very nearly as 2 to 1; and that the heats of formation of B_2O_3, CO_2, SiO_2, and P_2O_5, per equal volumes of the respective positive elements, are to each other very nearly

as 8, 6, 4, and 3. We have here a suggestion that the heats of formation of all compounds with the same negative element of non-metallic positive elements, whether belonging to the same family or not, are simple multiples of one unit quantity.

ON THE REFRACTION EQUIVALENTS OF THE DIAMOND, AND THE CARBON COMPOUNDS.*

By Dr. GLADSTONE, F.R.S.

The specific refraction of a substance is its refractive index minus one divided by its density, and this, which has for some time been recognised as an important physical property, promises now to be of great service to the chemist in deciding the rational constitution of many compounds. The refraction equivalent of a substance is this specific refraction multiplied by the atomic weight. Now the refraction equivalent of crystallised carbon, or diamond, is 5·0, and that is the value of this element in the large majority of its compounds; but in certain cases—as, for instance, the whole of the aromatic series—the carbon has a higher refractive value. Brühl, in a recent elaborate paper, has put forward the theory that wherever there is a double carbon atom with bands latent, the refraction equivalent is raised by about 2·0. The author of the present paper supported this view by some of his own observations hitherto unpublished, but contended that it failed to explain several other cases of high specific refraction, as, for instance, the essential oils, whether of the $C_{10}H_{16}$ or $C_{15}H_{24}$ class, which give refraction equivalents about three above the normal; the compounds containing cinnamyl; and especially the hydrocarbons which are richest in carbon, such as naphthalene, anthracene, and pyrene, which have a specific refraction far in excess of that calculated on Brühl's theory. It is remarkable that, whereas the refraction of the carbon increases rapidly in these hydrocarbons as the proportion of hydrogen diminishes, it has only the normal value in diamond where there is no hydrogen at all.

NITROSO-β-NAPHTHOL-SULPHONIC ACID.

(Preliminary Note.)

By RAPHAEL MELDOLA.

When a solution of a salt of β-naphthol-sulphonic acid (mono) is mixed with a solution of sodium nitrite in the proportion of 1 molecule of the latter salt to 1 mol. of the sulphonate, and the mixed solutions acidulated with dil. HCl, a deep orange-coloured liquid is obtained, from which the barium salt of nitroso-β-naphthol-sulphonic acid is precipitated on the addition of ammonia and $BaCl_2$. I have prepared and examined this nitroso-acid, and several of its salts and derivatives. It forms two classes of salts, typified by the barium compounds—

$$\left.\begin{matrix} C_{10}H_5.NO.HO.SO_3 \\ C_{10}H_5.NO.HO.SO_3 \end{matrix}\right\rangle Ba$$

And—

$$C_{10}H_5.NO\left\langle\begin{matrix} O \\ SO_3 \end{matrix}\right\rangle Ba.$$

The former crystallises in large flat orange needles containing 1 molecule of water of crystallisation, and the latter in microscopic green needles containing 2 mols. of water of crystallisation.

The most characteristic reaction of the nitroso-sulphonic acid is that with the phenols and amines, which results in the formation of a series of red and violet colouring-matters.

I hope to give full details of the experiments upon this new acid and some of its derivatives in a paper shortly to be presented to the Chemical Society.

Atlas Works, Hackney Wick
September 27, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Correspondenz-Blatt des Vereines Analytischer Chemiker.
No. 9, May, 1880.

The Sophistication of Oils.—M. Maumené.—In this memoir, which will be concluded in a future number, the author criticises the methods of Lefebvre, Rousseau, Cailletet, Calvert, Poutet, Boudet, and Heidenreich, and finds them all unsatisfactory.

Quantitative Determination of Glycerin.—Prof. Liebermann has examined the methods of Griessmayer and Lallieu for the determination of glycerin in beer, and gives the preference to the former.

Artificial Diamonds.—A report on the crystals obtained by Mr. Mactear and Mr. Ballantyne Hannay.

Beer Analysis by Prof. Vierthaler, of Trieste.—H. Lintner.—The author criticises severely Prof. Vierthaler's report and analysis of a certain Austrian beer.

Chemiker Zeitung.
No. 15, April 8, 1880.

Rubidium-thallium Chloride.—On evaporating a mixed solution of thallium terchloride and rubidium chloride Godeffroy obtained large well-defined crystals of the double salt. An analogous cæsium thallium double chloride was obtained in a similar manner.—*Zeitschrift Oest. Apoth. Vereins.*

Occurrence of Ozone on the Evaporation of Different Liquids.—A few drops of ether or alcohol are let fall upon a paper equably moistened with cadmium iodide-starch solution, and the volatile liquids are set on fire. After their evaporation the paper is found to be turned blue from the formation of ozone.—*Polyt. Notizblatt.*

No. 16, April 15, 1880.

Value of Reverted Phosphoric Acid in Superphosphates.—H. and E. Albert.—The writers contend for the utility of these reverted phosphates, and call for more experimentation.

Behaviour of Infusorial Earth with Dyes.—Dr. Reimann.—With reference to G. Engel's memoir on this subject the author maintains that he had observed as early as 1870 that silica in every state is readily dyed in virtue of surface attraction.

Behaviour of Bone-glue on Dry Distillation.—G. L. Ciamician and H. Weidel.—The authors did not obtain nitriles of the fatty acids and pyridine bases, but pyrrol, homo-pyrrol, and further members of this series, especially a crystalline body which they name pyrocoll, a derivative of Schwanert's carbo-pyrrolic acid. It was not obtained from the albuminoids.—*Sitzber. Ak. Wissen. Wien.*

Determination of Fecula in Potatoes.—P. Behrend, M. Märcker, and A. Morgen.—The starch is liquefied by boiling for four hours with water at 135° to 140° (3 grms. air-dry, finely-powdered starch to 50 c.c. water. The hot filtrate is completely converted into sugar by mixing with 20 c.c. hydrochloric acid and digestion for three hours in

* Communicated by the Author. Read before the Chemical Section of the British Association, Swansea Meeting, 1880.

the water-bath. After approximate neutralisation with potassa lye, and precipitation with 7 to 8 c.c. basic lead acetate, the liquid is made up to 500 c.c. In 200 c.c. of this solution, after the addition of 50 c.c. of sulphuric acid at 1 per cent, the sugar is determined by one of the methods proposed by the authors in the *Chem. Central-Blatt* (1878, p. 584) after the removal of the lead precipitate.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.
No. 77, May, 1880.
This number contains no original chemical matter.

MISCELLANEOUS.

Royal School of Mines.—Prof. W. Chandler Roberts, F.R.S., will deliver the Introductory Lecture to his course on Metallurgy, at 3 p.m., on Monday next, October 4th, at the Science Schools, South Kensington Museum.

Ozone.—MM. P. Hautefeuille and J. Chappuis have condensed ozonised oxygen at a pressure of 75 atmospheres and a cold of −23°. On removing the pressure signs of liquefaction appeared. In a condensed state, ozone is an indigo-blue gas. Full particulars will be given in next weeks CHEMICAL NEWS.

Trefriw Mineral Water.—An exceptionally well compiled Guide Book to North Wales, gives the following as the composition of the Trefriw mineral water :—"A strong solution of sulphate of iron and sulphate of alumina, with some sulphate of magnesia and soda and a little chloride of manganese, nickel, and *colchicum*." What a wonderful remedy for gouty and rheumatic patients!

City and Guilds of London Institute for the Advancement of Technical Education.—City Technical Science Classes.—

CHEMISTRY.—*Evening Classes.*—Dr. Armstrong will deliver a course of about thirty lectures on Organic Chemistty, with special reference to its industrial applications, on Mondays, 8.30 to 9.30 p.m., commencing October 4th. The first part of the course will chiefly consist of an account of the principles of Organic Chemistry. After Christmas, the Chemistry of the Coal Tar Products, their uses and the production of dyeing materials from them will be very fully considered. The Chemistry of Brewing, Spirit Distilling and Vinegar making processes will form the subject of the lectures after Easter. It is especially desirable that all who propose to attend either the second or third part of the course should also attend the first part, in order to gain the necessary preliminary knowledge. To give students attending the lecture an opportunity of making experiments in connection with the subjects treated of in the lectures, and also of discussing the lectures with the Professor, the laboratory will be open on Monday evenings at 6.30 to 8.30 o'clock. Students who shall have regularly attended the first part of this course, including the laboratory practice, and who shall on examination have given satisfactory evidence of proficiency, will receive a certificate which will entitle them to the full technological certificate on subsequently passing in any subject of the Technological Examinations of the Institute in which Organic Chemistry is one of the science subjects required. *Day Lectures.*—Dr. Armstrong will deliver a course of about twenty-four lectures on Tuesday and Friday afternoons at 4 to 5 o'clock, commencing October 5th. Although the chief object of these lectures is to afford such preliminary training as is necessary for those who may desire later on to study particular branches of Applied Chemistry, more than usual attention will be given to matters of technical importance. *Laboratory Classes.*—On and after October 4th, the laboratory will be open daily, Saturdays excepted, from 10 to 1 and 2 to 5 o'clock, for students desiring instruction in special applications of chemistry. A Laboratory Class for students attending the day lectures on chemistry, will be held on Tuesday and Friday afternoons at 1.30 to 4 o'clock. An Evening Laboratory Class will be held on Wednesdays at 6.30 to 9 o'clock, commencing Wednesday, October 6th. The individual requirements of students attending this class will as far as possible be considered. The Photographic Chemistry class will be continued on Wednesday evenings at 6.30 to 9 o'clock, commencing October 6th. It is proposed that students in this class should chiefly devote themselves to the study of Spectrum Photography and of Emulsion processes.

PHYSICS.—*Evening Courses.*—Professor Ayrton will deliver a course of evening lectures on Electrical Instrument Making, on Tuesdays at 8.30 to 9·30 o'clock, commencing October 5th, the first twelve of the lectures being given before Christmas. These lectures will be fully illustrated with experiments and practical illustrations, and especially adapted to the requirements of persons engaged, or intending to engage, in this industry. The practical details of the manufacture, adjustment and testing of electro-magnets, galvanometers, shunts, resistance coils, and condensers will be fully entered into, and the students will have the opportunity of performing themselves the experiments suggested at the lectures, as well as of obtaining information from the Professor regarding technical difficulties, by attending a special laboratory course, to be held on Tuesday evenings from 6.30 to 8.30 o'clock On Friday evenings, at 8.30 to 9.30 o'clock, commencing October 8th, Professor Ayrton will deliver a course of lectures, the first twelve being given before Christmas, on Weighing Appliances and Motor Machinery, adapted to the wants of makers and users of machinery. Lectures 1—3 will be especially suitable for Balance, Scale, Weighing Machine, and Dynamometer makers, and will form an introduction to the succeeding lectures, which will be on the relative efficiency of Steam, Hot Air, and Gas Engines, of Water Motors, and of Dynamo-electric Engines, and on the transmission of Power in factories and over long distances: the remaining lectures will be on Hydraulic Power Machinery. A special laboratory class for students attending this course will be held on Friday evenings from 6.30 to 8.30 o'clock. The physical laboratory will also be available on Tuesday and Friday evenings, from 6.30 to 9.30 o'clock, for students desirous of obtaining a practical knowledge of other branches of Technical Physics. *Day Lectures.*—Professor Ayrton will deliver a course of about 24 lectures on Monday and Wednesday afternoons, at 4 to 5 o'clock, commencing October 4th, on the Electric Light. *Day Laboratory Classes.*—A laboratory class especially suited for students attending the afternoon course of lectures will be held on Mondays and Wednesdays, at 1.30 to 4 p.m. Also on and after October 4th, the physical laboratory will be open daily (Saturdays excepted) from 10 to 1, and 2 to 5 o'clock, for Students desiring individual practical instruction in Technical Physics. Students attending regularly any of the above courses and passing a satisfactory examination will receive a qualifying certificate, entitling them to the full Technological Certificate of the Institute on passing the Technological examinations in allied subjects. Chemical and Physical Laboratories open daily (Saturday excepted) from 10 to 1, and 2 to 5 o'clock.

ERRATA.—Page 51 (July 30), col. 1, line 30, *for*—
$Sb^{-III}H^{+III}$, $As^{-III}H^{+III}$, *read* $Sb^{-III}H_3{}^{+III}$, $As^{-III}H_3{}^{+III}$
Col. 1, line 42, *for*—
$Pb_3{}^{VI}(PO_4)^{-VI=0}$ *read* $Pb_3{}^{VI}(PO_4)_2{}^{-VI=0}$
Col. 2, line 15, *for* $10H_2O$ *read* $5H_2O$.
" " 20 " HNO_3 " $8HNO_3$.
" " 40 " NO " $2NO$.

THE CHEMICAL NEWS.

VOL. XLII. No. 1089.

ON THE SPECIFIC ROTATORY POWER OF CANE- AND INVERT-SUGAR.*

By ALFRED H. ALLEN.

ACCORDING to the observations generally accepted, the angular rotation produced on a ray of polarised light by a plate of quartz 1 millimetre in thickness, is 24 angular degrees for the mean yellow ray or transition tint. In the construction of the polarising saccharimeter, which is known by his name, Soliel used a scale according to which these 24 angular degrees were divided into 100 parts, and he directed the user of the instrument to make a solution of the sugar of such strength that, if pure cane-sugar, a column of 20 centimetres in length would exert a rotatory power of exactly 100 solid divisions, or 24 angular degrees.

The formula commonly used for calculating the apparent specific rotatory power of optically active bodies in solution is as follows:—

$$S = \frac{a}{l \times \frac{c}{100}}$$

In this formula I have substituted S for the clumsy symbol $[a]$, which is usually used to denote specific rotatory power; a is the angular rotation observed; l, the length of the solution traversed by the ray of light (expressed in decimetres); and c is the concentration of the solution, or, in other words, the number of grammes of the solid present in each 100 c.c. of the solution.

According to the results of numerous observers, the value of S for cane-sugar is +73·8° for the mean yellow or transition tint. Substituting this value for S in the above equation, 24° for a, and 2° for l, we obtain:—

$$73{\cdot}8° = \frac{24°}{2 \times \frac{c}{100}} \; ; \text{ whence } c = 16{\cdot}26.$$

Hence the true quality of cane-sugar to be taken for use with Soliel's saccharimeter is 16·26 grms., and not 16·19, 16·35, or any other weight. If it be contended that either of these alternative quantities is the right one to employ, then it follows that +73·8° is not the true value of $[a]j$, or Sj; for cane-sugar, though this is the figure used in all our books.

According to Tuschmidt, a solution of cane-sugar, which before inversion produces a deviation corresponding to 100 divisions of the Soliel scale (=24°), after inversion, if the observation be made at 0° C., causes a deviation of 44·16 divisions in the opposite direction. This result is closely concordant with that of Casamajor, who gives −44 as the deviation of a solution of inverted sugar, which before inversion read +100 Soliel divisions. Casamajor also states that the diminution in rotatory power for increased temperature is 0·5 division for each degree centigrade, the solution becoming optically inactive at 88° C. (not at 90° C. as usually stated). Hence at 14° C., the inverted solution will read −37 divisions, and at 15° C. −36·5 divisions. These conclusions closely correspond with those of Tuschmidt, who gives a formula according to which the deviation of the inverted solution at 14° C. is −37·09 divisions.

In calculating the specific rotatory power of invert-sugar, Watts and many other authorities have apparently fallen into an error.* They appear to have assumed that a solution of inverted sugar, after correction for change of bulk, contained the same percentage of solid as before inversion. This, of course, is contrary to fact, 95 parts of cane-sugar yielding 100 of invert-sugar. Hence this increase in weight must be taken into consideration in calculating the specific rotatory power of the inverted sugar. Thus, according to the data already given, at a temperature of 15° C.,—

$$Sj = \frac{-36{\cdot}5 \times 0{\cdot}24}{2 \times \frac{16{\cdot}26}{95}} = -25{\cdot}6°.$$

This number corresponds to a value of −25·94° for Sj, at 14° C., instead of 25·0°, as is generally assumed.

If the number 16·19 be adhered to as the normal weight of sugar per 100 c.c. this value becomes,—

$$Sj = \frac{-37 \times 0{\cdot}24}{2 \times \frac{16{\cdot}19 \times 100}{100 \times 95}} = -26{\cdot}05 \text{ at } 14° \text{ C.},$$

against −25°, as generally taken.

If the specific rotatory power of invert-sugar be taken as −26° at 14° C. (which is the mean of the above values), and O'Sullivan's figure +57·6 be adopted as the value of Sj for dextrose, then the specific rotatory power of lævulose at 14° C. is −109·6°, instead of −106°, as usually taken.

$$26 \times 2 + 57{\cdot}6 = 109{\cdot}6.$$

To sum up, the corrected values of Sj for cane-sugar, invert-sugar, dextrose, or lævulose are:—

	Sj.
Cane-sugar..	+73·8
Invert-sugar	−25·6 at 15° C.
Dextrose	+57·6
Lævulose	−108·8 at 15° C.

Broch has found the deviation produced by a thickness of 1 m.m. of quartz equal to 21·67° for the sodium ray, while Girard and De Luynes take the same value as 21·8. Brown and Heron adopt the number 21·54. Tollens gives the number 66·5 as the value of S_D for cane-sugar solutions containing 10 per cent and upwards, a value which corresponds to 21·63. The mean of these four determinations is 21·66. Hence the foregoing values of Sj for the different varieties of sugar may be calculated into the corresponding values for S_D by the factor—

$$\frac{21{\cdot}66}{24} = 0{\cdot}9025.$$

* A paper read before the Chemical Section of the British Association, Swansea Meeting, 1880.

* Even in the new edition of "Miller's Organic Chemistry," edited by Armstrong and Groves, the specific rotatory power of invert-sugar is wrongly stated.

AN ECONOMICAL PROCESS FOR TREATING MINERAL AND OTHER SUBSTANCES CONTAINING SMALL QUANTITIES OF PHOSPHATE OF LIME.

By C. H. ALLDRED, F.C.S.

HAVING during the summer been making some investigations upon the decomposition of mineral and other phosphates of lime, the following results may be of interest. In trying nearly all the reagents capable of dissolving $3CaOP_2O_5$ I used a solution of SO_2 in water. This, as is well known, although it readily dissolves an artificially precipitated $3CaOP_2O_5$, does not so easily dissolve a mineral phosphate which is intimately mixed with SiO_2, CaO, Fe_2O_3, $CaSO_4$, &c., especially if it is an artificial product which has been heated or fused; and if the solution is warmed to assist decomposition, of course the SO_2 is driven off, and any phosphate of lime which had been

taken up is precipitated as a bisulphited phosphate of lime, which remains insoluble, mixed with the material under treatment. Thus SO_2 cannot be practically employed in this manner. To prevent the occurrence of this difficulty I tried the following plan:—The material employed was a refuse product containing about 22 per cent of $3CaOP_2O_5$, 12 per cent of Fe_2O_3 and Fe_3O_4, and the remainder consisting of CaO, SiO_2, MgO, &c. This was finely ground, and placed in a small boiler lined with lead, fitted with a hot-water jacket. It was then nearly filled with a saturated solution of SO_2 in water. The boiler was then firmly closed up, and the whole heated until the water in the outer jacket (which was not under pressure) boiled, and kept at this temperature for five or six hours; it was then allowed to cool, and the contents filtered. The filtrate contained a large amount, nearly the whole (but a quantitative experiment was not made), of the $3CaO+P_2O_5$, and only a small amount of iron. The former can be precipitated either by adding CaO, or, better, by boiling, when it is precipitated in a fine white powder as a nearly pure bisulphited phosphate of lime, which has a high value as a fertiliser. In putting this process into practical application it would only be necessary to have two boilers lined with lead or other suitable metal. Into the first (A) is charged the phosphatic material, and the solution of SO_2 then heated, but by means of a water-jacket, up to 100° C., when there will be a pressure of about 20 to 30 lbs. per square inch. After being kept at this temperature for, say, six hours, a tap is opened near the bottom, connected with a pipe which leads to the boiler (B), which should be placed on a lower level than A. When this is filled with the liquor it is boiled, the expelled SO_2 being led off from an escape pipe, which will conduct the gas into cold water, where it may be re-absorbed, and the solution be used for the treatment of a fresh batch of raw material. The liquor and precipitated bisulphited phosphate of lime in the boiler B can be run off into settling tanks, when the phosphate can be filtered, pressed, and dried. In this process the SO_2 would to a great extent be recovered, the only loss being that combined with the phosphate of lime and the loss from leakage. To make up these losses, for the supply of SO_2 I propose preparing it from pyrites, sulphur, or H_2SO_4 and coke.

The adoption of this process offers an economical means of treating many substances containing $3CaO,P_2O_5$ in quantities too small to pay for treatment by acids, and especially for localities where large deposits of phosphates occur, but too poor to pay for transit in their natural state.

106, Leadenhall Street, E.C.
September 30, 1880.

A SIMPLE PROCESS OF SLOW ACTINOMETRY.

By ARTHUR DOWNES, M.D.

DR. LEEDS'S paper, published in the CHEMICAL NEWS, page 147, induces me to submit the following remarks:—Of the various methods of actinometry hitherto suggested there is not one, so far as I am aware—though on this point I would speak with all diffidence—which is adapted for the measurement of solar chemical work for weekly or monthly periods, and which is at the same time so simple that it may be used by anyone with little trouble and without necessity for elaborate apparatus. In 1877-78 some experimental observations by Mr. Blunt and myself* were published demonstrating the destructive action of sunlight upon bacteria and other low organisms, and we adduced evidence to show that this was due to excessive oxidation, under insolation, of their protoplasmic substance. In the course of this enquiry we discovered that a decinormal solution of oxalic acid was after a certain interval entirely decomposed by sunlight by oxidation, thus—

$$2C_2O_4.H_2+2O_2=4CO_2+2H_2O+O_2;$$

the view taken in the above formula being that in sunlight the affinity of oxygen for the basylous hydrogen is so stimulated as to exceed that of the chlorous radicle C_2O_4, just as, under other circumstances, oxygen itself may be superseded by chlorine. In darkness the balance is not disturbed, and ordinary oxygen has no power to displace the oxalyl radicle. Solutions of oxalic acid may be preserved for long periods if the light be carefully excluded, and care be taken to prevent decomposition by fungi.

Wishing, in case I had an opportunity of resuming certain points in connexion with our original enquiry, to have the means of expressing arithmetically the oxidising power of sunlight during periods of days, weeks, or months, it occurred to me, early in the present year, to turn this oxalic acid reaction to account.

Hitherto want of time and other circumstances have prevented me from working out the problem fully. My procedure has been to expose in small-sized test-tubes a measured quantity of decinormal oxalic acid, and, after the desired period of insolation, to determine the amount of oxidation by direct titration with permanganate. In this way I have made weekly observations since last March, and, rough as these are, the result leads me to believe that this process may be made one of great value to the meteorologist, agriculturist, and sanitarian.

The chief difficulties in the way of its application appear to be, first, that the tubes employed must be as nearly as possible of identical section-area, the extent of surface exposure being, as may be expected *a priori*, a most important factor in the result. Until within the last few days I have, for various reasons, not been able to obtain a set of tubes fulfilling this essential requirement. Mr. Casella, of Holborn, has, however, with great care selected me some which, save for the thickness of the glass, appear likely to answer my purpose excellently. They have a sectional area of 4 square centimetres. Another difficulty which I hope to overcome or reduce to a minimum is the apparently varying rate of oxidation according to the concentration of the solution.

To both these sources of difficulty and error it appears to me that both Dr. Leeds's potassic iodide process and the ferric oxalate process, suggested by Draper years ago, add another from which the oxalic process is quite free, viz., variation of colour.

I may note in conclusion that in a paper* "On the Behaviour of the Alkaline Oxalates in Sunlight," read June 19, 1879, Mr. Blunt and I remarked that we had satisfied ourselves, first, that in a Sprengel vacuum a 10 per cent solution of pure potassic iodide remains perfectly colourless in sunlight; and, secondly, that decomposition invariably occurs in an insolated solution when no other gases than nitrogen and oxygen are present. We concluded, therefore, that the well-known decomposition of potassic iodide in sunlight was due to the oxidation of the alkali metal.

* *Proceedings of the Royal Society*, No. 184, 1877; and No. 191, 1878

THE STABILITY OF CALOMEL.

By PHIL. HOGLAN, Ph.G.

IN the *Druggists' Circular* for August, 1880, is a statement from M. Verne, a French pharmaceutist, on the Stability of Calomel, which statement is copied from the *Bulletin de Thérapeutique*. M. Verne finds that calomel mixed with chloride of sodium, sugar, or citric acid undergoes no change, and that therefore the asserted danger of prescribing them at the same time is fictitious. The conversion of calomel into corrosive sublimate by the chlorides of the alkaline metals, and also by the organic acids, has for a long time been a much vexed question; and the purpose of the following experiments was to discover the cause of the great discrepancies on this subject, and also to ascertain the correctness of M. Verne's assertion that "the

* *Proc. Roy. Soc.*, No. 197, 1879.

danger of acid drinks when using calomel is pure prejudice."

Experiments.

A. Calomel was mixed with a solution of chloride of sodium, and after standing ten days, at the temperature of 78° F., the filtered liquid gave no evidence of the presence of corrosive sublimate by the stannous chloride test.

B. Calomel and citric acid were treated in the same manner, and after fifteen days the filtered liquid gave a slight greyish tinge with stannous chloride, indicative of the presence of corrosive sublimate.

C. Calomel and sugar were treated in the same manner, and after fifteen days no evidence of corrosive sublimate could be found in the filtered liquid.

D. Calomel and solution of chloride of sodium were maintained at a temperature of 98° F. (temperature of the body) for one hour, when the filtered liquid gave evidence of the presence of corrosive sublimate.

E. Calomel and sugar and calomel and citric acid, treated in the same manner at the same temperature, also gave a reaction indicating the presence of corrosive sublimate.

F. Calomel and water, treated in like manner for three hours at 98° F., gave a very slight reaction with stannous chloride. Not so marked as previous ones.

These experiments show, first, that calomel is slowly converted into corrosive sublimate by water at the temperature of the body. Secondly, that chloride of sodium, citric acid, and sugar greatly promote the conversion of calomel into corrosive sublimate, and hence are more or less dangerous when present in the system with calomel. Thirdly, that the discrepancies in regard to the stability of calomel are, in part, accounted for by taking into consideration the temperature at which the experiments have been conducted. Fourthly, that at the temperature of the human body calomel is an unstable compound.

Newcomerstown, Ohio,
September 10, 1880.

ON THE LIQUEFACTION OF OZONE, AND ON ITS COLOUR IN THE GASEOUS STATE.

By MM. P. HAUTEFEUILLE and J. CHAPPUIS.

Ozone, as commonly prepared, possesses in oxygen so small a tension, 53 m.m. at most, that its physical properties are scarcely known and distinguished from those of oxygen. We know the difficulties which M. Soret has so skilfully overcome in determining the density of ozone by operating upon oxygen slightly ozonised.

Among the physical constants of this body its formation-heat has been accurately determined by M. Berthelot, notwithstanding the degree of dilution in which it occurs when issuing from the effluve apparatus. The preparation of a mixture very rich in ozone is the first condition to be fulfilled in order to acquire new notions concerning this curious substance. We have formerly established that the isomeric transformation of oxygen submitted to the electric effluve follows simple laws, and that the proportion of ozone increases very little with the pressure for each temperature, whilst it is quintupled in passing from 20° to −55°. If withdrawn from the action of the electric discharges the mixture of ozone and oxygen ceases to be a homogeneous system in equilibrium. Nevertheless the mixture remains without appreciable alteration during the whole time that a constant temperature is maintained, operating below 0°. This relative stability of ozone has enabled us to compress the mixture, and to obtain tensions of ozone of several atmospheres.

As it is necessary to prepare the ozone designed for these experiments at the highest tension possible, oxygen must be ozonised at a very low temperature. Consequently it is kept for a quarter of an hour in an apparatus for alternative discharges, the slender concentric glass tubes of which are plunged in methyl-chloride; then it is caused to pass into the cylinder terminated by a capillary tube of Cailletet's apparatus. This reservoir, of about 60 c.c. capacity, originally a vacuum, and kept at −23°, cannot be filled at once under a pressure bordering upon 760 m.m., and is rapidly connected 5 times in succession with the effluve apparatus, the capacity of which cannot exceed 20 c.c. In an hour and a quarter we succeed by this means in filling the cylinder with a mixture of oxygen and ozone very rich in the latter gas.

The cylinder is then taken out of the methyl-chloride, and separated from the effluve apparatus by a stroke of the file; the gas which it contains is slowly driven back by means of mercury cooled down to 0° into the capillary tube, which is kept at −23°.

The mercury which transmits the action of the hydraulic press does not impoverish the gaseous mixture as rapidly as might be apprehended; there is formed on the surface of the metal a solid varnish, which rapidly limits the action; the heating of the gas during compression is more to be feared. Notwithstanding these difficulties we succeed in increasing the tension of the ozone in a very high proportion. From the first strokes of the piston the capillary tube becomes a sky-blue. This colouration becomes more marked in proportion as the volume of the gas is reduced, and if the tension of the gas is brought by compression to several atmospheres the gas is an indigo blue, and the meniscus of mercury, seen through the gas, a steel-blue. The blue colour of the gas becomes less intense, and the mercury resumes its ordinary metallic aspect when the tension of the ozone is diminished.

The above mixture contains enough ozone to permit the observation of a dense white mist at the moment of release after a compression of 75 atmospheres. It is therefore not necessary to compress ozonised oxygen as much as pure oxygen (300 atmos.), in order that a sudden release may occasion the momentary formation of a mist, the certain sign of liquefaction or even solidification. A comparative study of mixtures of oxygen and ozone, and of oxygen and carbonic acid, shows that under conditions which are fairly comparable the release must be stronger for ozone than for carbonic acid in order to make a mist appear. Ozone is therefore a little less easily liquefied than carbonic acid.

The mixture of oxygen and ozone, being an explosive gas, should always be compressed slowly and refrigerated. If these conditions are not observed the ozone is decomposed with the liberation of heat and light, and there is a strong detonation attended with a yellowish flash. M. Berthelot has shown that the transformation of oxygen into ozone absorbs 14·8 cals. per equivalent (O_3=24 grms.). Ozone therefore ranks among the explosive gases, and our experiments show that like them it is capable of a sudden decomposition. A part of these new facts may also be observed in oxygen which has been passed slowly at common temperatures through an effluve apparatus. For if the gas is rapidly compressed in a capillary tube placed in water at 25° the ozone is often destroyed with explosion. But if the same gas is cooled down to −23° the ozone which it contains may be brought to a tension of 10 atmospheres, and may be preserved for hours under these conditions of pressure and temperature if the gas is separated from the mercury by a column of sulphuric acid. We observe then almost as distinctly as in the former experiment, which is more difficult to perform, that ozone is a gas of a beautiful sky-blue. Its colour at a tenfold density is so intense that we have been able to see it in a tube of 0·001 metre in diameter when operating in a very badly lighted room of the laboratory of the Ecole Normale.

It is therefore ascertained that under a strong pressure ozone is a coloured gas, but is it the same with ozone at the tension of a few millimetres? The blue colour is as

characteristic of ozone as its odour, for at all tensions it is recognised on examining a stratum of the gas of sufficient depth. In order to render it apparent it is merely needful to interpose between the eye and a white surface a tube of 1 metre long traversed by the current of oxygen which has passed through Berthelot's effluve apparatus. The colour of the gas then resembles that of the sky, and is deeper or lighter according as the oxygen has remained a longer or shorter time in the apparatus, and is consequently more or less rich in ozone. As soon as the effluve is interrupted the blue colour disappears, the ozonised oxygen being replaced by pure oxygen.—*Comptes Rendus.*

[The authors add in a note that in a future communication they will make known the part which this coloured gas may play in the atmosphere, and what may be its effects upon the different radiations.]

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY IN THE LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. IX.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(53.) *On the Existence and Properties of Phosphorus Pent-Iodide.* By Frank Hampton, of Columbia, South Carolina.

It is usually said that phosphorus unites with iodine in but two proportions, forming a di-iodide and tri-iodide, but no pent-iodide corresponding to the higher bromide or chloride. In Gay Lussac's chief memoir* upon iodine, however, containing the results of the experiments made by him with the newly-discovered element of Courtois, he states that on bringing together 1 part of phosphorus and 16 of iodine a grey-black crystallised substance was formed, fusible at 29° C., and producing on contact with water a colourless solution which contained hydriodic and phosphorous acids; while 1 part of phosphorus with 24 of iodine gave a black substance, fusible "*en partie*" at 46°, and dissolving in water with elevation of temperature, the solution containing hydriodic and *phosphoric* acids and exhibiting a dark brown colour from the presence of free iodine. Mr. Hampton undertook to examine the latter of these reactions, and to ascertain if possible with certainty whether phosphorus pent-iodide can really be obtained.

He made several experiments with concordant results. In some the two elements were brought together in a neutral atmosphere of pure nitrogen, without any other additional substance being present, but it was found difficult to regulate the violence of the action and to prevent objectionable rise of temperature. In others, therefore, carbon disulphide was used to dissolve and so dilute the phosphorus before the addition of the iodine; and with proper precautions this was found to produce no change in the final result, while rendering the process much more easily manageable. The following notes were made of one of the experiments by this latter method, which was carried out with all possible care:—

A supply of nitrogen was prepared by burning phosphorus in bell-glasses filled with air, and the gas stored in a large gas-holder. It was purified by passing it first through a long tube coated on the inside with phosphorus maintained at a temperature a little above its melting-point, then through a solution of potassium hydrate, then over pumice-stone soaked with a stronger solution of the same, then through strong sulphuric acid, and finally over pumice-stone moistened with pure sulphuric acid of full strength. A slow stream of this gas was passed continuously through a flask, of 300 c.c. capacity, furnished with inlet and outlet tubes, in which flask 0·995 grm. of ordinary crystalline phosphorus was dissolved in a few cubic centimetres of carbon disulphide. 41·589 grms. of pure iodine were added in portions, with due precaution against any admission of air; this being a little in excess of the 40·767 grms. required by the formula PI_5. When the solution of the iodine was complete, the carbon disulphide with most of the excess of iodine was gotten rid of by distillation at 45° C. under slightly reduced pressure, the flask being immersed in a large vessel of water kept at the temperature named, and the outlet tube connected with a vessel in which exhaustion to the extent of a few inches of water was produced by a filter-pump. To remove the last traces of iodine without allowing it to condense upon the neck of the flask, a U-shaped tube of about 5 m.m. in diameter had been previously passed through the cork closing the flask, with the bend inside reaching nearly to the bottom, and through this tube a current of cold water was circulated. When all of the iodine removable at 45°, with the exception of mere traces, had been driven off, the temperature was raised to 50°, and being kept for some time at this, the material at the bottom of the flask was slowly and in small quantity volatilised under the reduced pressure, the last portions removed on the exterior of the U-shaped condensing tube proving to contain phosphorus in sensible amount, and giving the same results on decomposition with water or an alkaline solution as the main portion left behind in the flask. On raising the temperature still further to 55° signs of decomposition became apparent, purple vapours of iodine being again given off, and the appearance of the residue changing at the points most heated. The flask was now quickly cooled, keeping up the stream of nitrogen, and immediately afterwards a solution of sodium hydrate, from which all oxygen had been expelled by previous boiling, was carefully run in through a tube provided for the purpose and hitherto kept closed, avoiding any entrance of air, until the alkali was in very slight excess. The flask was cooled from the outside with ice-water to prevent rise of temperature, to which there was a strong tendency. These precautions were necessary in order to negative the assumption afterwards that phosphorous acid or its sodium salt had been first formed and then converted by heat or the presence of oxygen into the corresponding phosphoric compound. Ammonio-chloride of magnesium, as commonly used for the precipitation of phosphoric acid, was now run in as long as it produced a precipitate, and this precipitate was filtered off without access of air. The bulk of the precipitate being too large for accurate ignition and weighing, it was re-dissolved in hydrochloric acid, and phosphoric acid determined in a definite fraction of the solution. The filtrate from the original precipitate was also brought to a definite volume, and in one fraction of it iodine was determined as iodide of silver, while in another the phosphites were oxidised to phosphates by means of nitric acid, and the phosphoric acid determined as magnesium and ammonium phosphate.

The following results were obtained:—

Phosphorus found present in original alkaline solution as sodium phosphate ..		1·371 grms.
Ditto, ditto, as sodium phosphite		0·562 ,,
		1·933 ,,
Hence, phosphorus volatilised in heating materials together		0·062 ,,
Total phosphorus employed		1·995 ,,
Total iodine found present in alkaline soln.		35·040 ,,
1·371 grms. P requires for PI_5 (calc.)	28·016 grms. of I	
0·562 grm. P requires for PI_3 (calc.)	6·890 grms. of I	
	34·906	34·906 grms.

* *Annales de Chemie*, 91, 10 (August 1, 1814).

The apparent slight excess of iodine (the alkaline solution having been colourless) undoubtedly represents a real but much smaller loss of phosphorus in the two determinations of the latter.

It appears, therefore, that phosphorus pent-iodide is obtainable by the direct union of its elements, and that in this particular experiment the mass remaining in the flask, after partial decomposition from over-heating had taken place, consisted approximately of—

PI_5	80·0
PI_3	20·0
	100·0

Taking the material in the flask as it appeared when decomposition had not yet set in, or had occurred to but a trifling extent, the pent-iodide formed a very dark crimson, almost black, mass of crystalline structure, made up seemingly of thick needles or slender prisms, unlike the stouter crystals or flat scales of iodine itself. Its limit of stability was found pretty close to 50° C.; above this temperature it decomposed, giving off iodine, and becoming reduced to the tri-iodide. This dissociation is of course paralleled by that experienced at successively higher temperatures by the penta-bromide and penta-chloride. At 50°, as has been stated, the pent-iodide was under reduced pressure volatilised in minute amount, the small quantity collected on the condensing tube giving on treatment with water phosphoric as well as phosphorous and hydriodic acids. On simple exposure to air of the main product from the flask it absorbed moisture, and gave off heavy yellowish fumes of suffocating odour. In one experiment, in which carbon disulphide was used, and the attempt made to distil it off under full atmospheric pressure, a red substance was noticed in small quantity, which may have been identical with that observed by H. Jahn* and Baeyer.†

(54.) *On the Composition of Dufrenite from Rockbridge Co., Va.* By F. A. Massie, of the University of Virginia.

During the last three or four years several American dealers in minerals have sold specimens labelled "Dufrenite, Rockbridge Co., Va.," but I have been unable hitherto to find out upon whose authority the determination of species rests, by whom, at what precise locality, or under what geological conditions the mineral in question was found. No description or analysis having been published, so far as I know, a good specimen was placed in Mr. Massie's hands for examination.

The mineral occurs in nodular masses of various sizes, up to several inches in diameter, showing well-marked radiated structure on being broken, the mass being made up of slender prisms closely compacted. Hardness = a little over 4; sp. gr. = 3·454; faint silky lustre; colour very dark blackish green, almost black, streak greyish green. On the outside of the nodules a layer, 5 to 10 m.m. thick, of altered mineral has a red-brown colour. Nearly opaque; readily fusible before the blowpipe flame; gives off water when heated to redness in a glass tube, slightly decrepitating, and gradually changing to a red-brown colour; soluble in strong hydrochloric acid. Choice portions of the mineral, appearing under a lens quite homogeneous, were selected for analysis.

Qualitative chemical examination proved that the iron exists partly in the ferrous and partly in the ferric state, and that neither calcium nor the alkaline metals, arsenic nor fluorine, is present. The ferrous iron was determined in a portion of the mineral decomposed by strong sulphuric acid in an atmosphere of carbon dioxide. Phosphoric acid was determined by means of ammonium molybdate, and manganese by bromine. Full analysis yielded the following results, two or three of which were obtained by averaging several closely accordant determinations. Dried over sulphuric acid 0·03 per cent, and heated in a steam-bath 0·8 per cent, of water, manifestly non-essential, was lost and the residue contained—

Ferric oxide	50·89
Alumina..	0·29
Ferrous oxide	6·06
Manganous oxide..	0·24
Magnesia	2·16
Phosphorus pentoxide..	31·66
Silica	0·20
Water	8·35
	99·85

The minute amount of silica probably exists as quartz being left as a gritty powder undissolved by hydrochloric acid. Neglecting this, and counting the little aluminium along with ferric iron, and manganese and magnesium with ferrous iron, the above figures correspond pretty nearly to a mixture of normal dufrenite,—

$$Fe'''_2(HO)_3PO_4,$$

with anhydrous ferrous pyrophosphate,—

$$Fe''_2P_2O_7,$$

in about the ratio of 3 molecules of the latter to 4 of the former. It would require but little alteration of the figures, however, to make the residue ferrous *ortho*- instead of pyro-phosphate, which is more probable. It is to be noted that in analyses already on record of dufrenite from Siegen* and from Allentown, New Jersey,† ferrous iron has been found, but no notice is taken of this in the formula usually written for the mineral.

(To be continued.)

CHARACTERISTIC TESTS OF BEES'-WAX, VEGETABLE AND ARTIFICIAL.‡

By H. HAGER.

The analysis makes the following processes necessary:—

1. *Determining the Specific Gravity.*—In case the mass does not contain moisture, cut off five or more small pieces or melt a few grammes in an evaporating dish supplied with a lip, drop the wax on a pane of glass, which has previously been wiped off with a moist cloth, and place the glass into cold water. The drops will either readily drop off at the slightest touch, or are removed at the expiration of half an hour with a knife. The specific gravity is then determined as usual by the floating test, which consists in mixing alcohol and water in such a proportion that the wax-drops will float in the mixture without showing a tendency to rise or sink. The drops containing air-bubbles can be readily recognised and are rejected. The specific gravity of pure yellow or white wax lies between 0·956 and 0·964, usually between 0·958 to 0·960. If, therefore, the specific gravity of the suspected wax is not between 0·956 to 0·964 it is very probably adulterated. Wax containing an admixture of stearic acid, resin, or Japan vegetable wax has usually a higher, and wax adulterated with tallow, paraffin, or ceresin, a lower specific gravity.

2. *Dissolving in Hot Chloroform or in a Fatty Oil.*—The solution of dry bees'-wax is clear, but slightly cloudy in case the wax was moist, but ought not to contain any sediment, which, if present, ought to be collected and determined (mineral substances, starch, &c.).

3. *Borax Test.*—6 to 8 c.c. cold saturated borax solution are heated in a test-tube with a piece of the suspected wax as large as a bean, until it melts, when the mixture is shaken gently. The aqueous liquid becomes slightly cloudy if the wax is pure bees'-wax, but never becomes milky. When set aside for cooling the layer of wax collects

* *Ber. der Deutsch. Chem. Gesell.*, 13, 127, 135.
† *Ann. de Chem.*, 155, 266.

* Schnabel—Rammelsberg; *Hand. d. Min. Chem.*, 329.
† Kurlbanna, *Amer. Jour. Sci.*, ii., 23, 423.
‡ Translated and condensed from *Pharm. Centralh.*, April 8, 1880 pp. 119-121, by Louis von Coltzhausen, Ph.G.

on the surface of the liquid, leaving the latter almost clear, or only slightly turbid or half translucent. If it becomes milky immediately, and remains translucent and milky even after cooling, either Japan vegetable wax or stearin are present. Resin and Brazil vegetable wax act like pure bees'-wax in this test.

4. *Soda Test.*—Mix in a test-tube a piece of wax, the size of a bean, and 6 to 7 c.c. sodium carbonate solution (1 salt, 6 water). Heat in such a manner that the upper layer of the liquid is heated without agitation until the wax is melted. If much froth is noticed at the wax layer stearic acid is probably present. The whole is then heated to the boiling-point. If the liquid becomes milky, milky-yellowish, or milky-white, Japan wax or stearic acid is present. In this case the aqueous liquid remains milky, even after cooling; in case Japan wax is present, more or less pasty, or even stiff, while if stearic acid is present the milky layer is usually liquid, and often appears crossed by clear layers. The wax layer on the surface is usually brittle and not hard.

Pure bees'-wax appears hard after cooling slowly, and the aqueous layer is cloudy, but not milky, frequently semi-translucent and entirely liquid.

If the bees'-wax contains pine resin this test will cause an entire separation of the resin. Instead of merely heating to the boiling-point, allow to boil for one minute, and then to cool gradually. The mass then consists of three layers, an upper hard wax layer, a liquid, slightly turbid, middle aqueous layer, and a loose or flocculent resin layer on the bottom. The resin can then, of course, be readily determined quantitatively.—*American Journal of Pharmacy.*

NOTICES OF BOOKS.

Elements of Chemistry, Theoretical and Practical. By WILLIAM ALLEN MILLER, M.D., D.C.L., LL.D. Revised and in great part re-written by H. E. ARMSTRONG, Ph.D., F.R.S., Sec. Chem. Soc., and CHARLES E. GROVES, F.C.S., Sec. Inst. Chem. Part III.—Chemistry of Carbon Compounds, or Organic Chemistry. Section 1.—Hydrocarbons, Alcohol, Ethers, Aldehydes, and Paraffinoid Acids. Fifth Edition. London: Longmans and Co.

THE reviewer has far more difficult tasks than to deal with re-issues of a work which has once for all established itself in public opinion, since censure, praise, and mere exposition have each and all been anticipated. The present case is, however, somewhat exceptional, since the organic portion of Prof. Miller's work has been almost entirely re-written by the editors, who have merely retained such portions of the original as have remained unaffected by recent discoveries.

The editors remark that since the appearance of Kekulé's "Lehrbuch" no comprehensive work on the organic compounds has been attempted. Hence their task has been far from easy. They hope, however, that the summary which they have given of the carbon compounds, as they are regarded by modern chemistry, will be found trustworthy. They consider that "Mendelejeff's so-called periodic law may be regarded simply as an extension of the laws which govern the carbon compounds to the elements generally." They give the opinion that what is most required in chemistry is "the accurate and complete examination of individual carbon compounds, for chemists have hitherto too often been satisfied if they simply prepared a given substance, analysed it, and described a few of its reactions; a compound is seldom obtained in quantity sufficient to admit of its complete purification and the subsequent determination of its physical constants. These constants can be most advantageously determined by those who have the necessary apparatus at their command, and, above all, special experience in such matters; and if each chemical school would make the preparation by its students of certain substances in a state of purity a part of the ordinary course of study, and would give notice that these particular compounds were at the service of experts for the determination of physical constants, much would be done to facilitate the study of a comparatively neglected branch of science."

This is, we consider, a most excellent suggestion; the preparation of pure bodies would be in itself a wholesome discipline for the students, and many researches would be undertaken which are now shunned on account of the loss of time involved in obtaining pure materials.

The first chapter of the work is devoted to organic analysis, ultimate and proximate, the determination of vapour densities, and their use in ascertaining molecular formulæ.

In the second chapter the editors treat of quantivalence, the classification of the carbon compounds, and the theory of compound radicles and of chemical types. They give in a note the caution as "scarcely necessary" that the "graphic illustrations employed to aid the conception are not intended in any way to represent the relative position of the atoms, but merely to show whether the compound is a saturated or unsaturated group or molecule." We fear that this caution is very often more or less consciously lost sight of by chemists. The theory of organic radicles they also very prudently declare "cannot be supposed to afford a correct representation of the constitution of organic bodies, but it is a convenient fiction which materially facilitates the retention of their composition in the memory, and the comprehensions of the changes which such compounds undergo." From this point of view it becomes utterly unimportant whether an organic radicle can be isolated or not, or even whether it would be capable of independent existence, or what would be its behaviour in contact with the substances which it accompanies.

The third chapter treats of the action of reagents on carbon compounds. Here the authors lay due emphasis on the value of limited oxidation in the study of organic compounds.

Into the remaining chapters of the work, which are devoted to a description of the principal classes of organic bodies, we cannot here enter.

In Chapter X., § 11, the editors take into consideration the insufficiency of the present theory of isomerism, which at any rate does explain the case of the terpenes and citrenes,—sets of bodies which are chemically undistinguishable, but whose optical behaviour is quite different. They then proceed to an examination of the asymmetric carbon atom hypothesis proposed by Van 't Hoff and Le Bel, which, however, they consider scarcely sufficient.

A companion volume is to contain the acid of the aromatic or benzenoid group, the basic nitrogenous compounds, and the organo-metallic compounds. The whole will undoubtedly form an admirable compendium of organic chemistry.

Bulletin of the Washington Philosophical Society. Vol. I., March, 1871, to June, 1874; Vol. II., October 10, 1874, to November 2, 1878; and Vol. III., November 9, 1878, to June 19, 1880.

THE word "philosophical" in the title of the Washington Society is used, we are told, "not to denote, as it generally does in the present day, the unbounded field of speculative thought which embraces the possible as well as the actual of existence, but to be used in its restricted sense, to indicate those branches of knowledge that relate to the positive facts and laws of the physical and moral universe." We should have thought that "Scientific Society" would have been the better name.

Among the memoirs which have been laid before this learned body there are not a few which were of great interest at the date of their publication, but which have become so well known that any abstract or criticism would now be quite out of date. Of many other papers we find

here merely the titles, with the intimation that they have been published elsewhere. The memoirs to which the greatest proportion of space is accorded seem those treating on mathematics and on certain portions of political economy.

Prof. Joseph Henry's discourse on the Method of Scientific Observation (vol. ii., p. 163) contains exceedingly sound views. The death of the speaker followed very shortly after, and the remainder of the volume is taken up with an account of his life and researches.

In vol. iii. mention is made of a paper by Mr. L. F. Ward, on the "Origin of the Chemical Elements," but it is unfortunately not inserted even in abstract. About a fourth part of the volume is devoted to a paper and accompanying discussions on the "Silver Question." Chemistry, as far as can be judged from the printed papers, does not seem a favourite subject with the Philosophical Society of Washington.

If we might suggest, these volumes would be greatly improved by the addition of an index or a table of contents.

Traité d'Anæsthésie Chirurgicale, contenant la Description et les Applications de la Méthode Anæsthésique de M. Paul Bert. Par le Docteur J. B. Rottenstein. Paris: Germar Baillière et Cie. (Treatise on Surgical Anæsthesia, containing the Description and the Applications of the Anæsthetic Method of M. Paul Bert.)

This work belongs to the sphere of practical surgery rather than to that of chemistry. After a survey of the rise and progress of anæsthesia, the author describes the properties and preparation of nitrous oxide, ether, chloroform, amylene, and chloral, and passes thence to a consideration of their respective advantages and of the appliances for their administration. He gives the preference to M. Paul Bert's, which consists in the inhalation of a mixture of equal volumes of air and nitrous oxide under the pressure of two atmospheres. For very brief operations nitrous oxide may be used alone. Where Bert's apparatus is not to be had, the author recommends the method of Clover,—*i.e.*, the initial use of nitrous oxide followed up by ether. Chloroform should only be employed under exceptional circumstances.

CORRESPONDENCE.

THE THALLEIOQUIN TEST.—A RECLAMATION.

To the Editor of the Chemical News.

Sir,—Turning over some recent numbers of your journal, I met with an old friend disguised by a new name.

Mr. Charles Frederick Zeller, in an inaugural essay, thus delivers himself on the above-named subject:—

"This test, which is one of the most beautiful of the alkaloidal tests, was accidentally discovered by M. J. J. Andre, in 1835," who is stated to have presented a memoir to the College of Pharmacy of Paris, "On the Action of Acid on Quinia," which was transferred to the *American Journ. of Pharm.*, in 1836.

Now, I think the evidence subjoined will prove that the discovery was really made by a then student at Guy's Hospital, and afterwards either independently discovered by M. Andre, or merely adopted by him as a waif and a stray. M. Andre, if yet in the flesh, may determine this question, or, failing him, his scientific executor, Mr. Zeller, will doubtless fulfil this duty and restore this little leaf of his chaplet to the rightful owner.

Anyone who cares to do so, and who will consult the *Philosophical Magazine and Journal of Science* of the year 1835, page 158, will find a letter addressed to the Editors, containing the following statements, which will suffice for my purpose:—

"Morphia.—If a solution of this substance or any of its salts be mixed with a strong solution of chlorine, and ammonia be added, a brown colour will pervade the solution . . . . but if quinia, or any of its salts, be treated in the same way, a beautiful green colour will be observed, which will become red on the addition of an acid. The test is a delicate one, and will detect a grain of either of these alkaloids in a pint of solution, &c., &c.

"(Signed) H. A. Meeson.

"Guy's Hospital, January 7, 1835."

Mr. Meeson submitted his observations as being possibly of value "in a medico-legal point of view," and I submit them to your readers as justifying my ascription of the merit of the discovery of this test to this student of Guy's, who, I think, died young, instead of M. J. J. Andre.—I am, &c.,

J. Denham Smith.

Fair Lawn, Combe Wood, Sept. 29, 1880.

FRACTIONAL DISTILLATION OF BENZOL.

To the Editor of the Chemical News.

Sir,—Reading through Schutzenberger's "Traité des Matières Colorantes" the other day, I met with the following, to me, remarkable statemen. Htaving described the apparatus for, and the process of, fractional distillation, he says:—"La benzine continue à distiller jusqu'à ce qu'elle soit épuisée et la température du vase réfrigérant monte jusqu'à ebullition. A première vue on croirait que l'eau bouillante, échauffant l'appareil, permettrait aux vapeurs de passer; mais, au contraire, l'ébullition de l'eau refroidit considérablement les vapeurs; *et plus l'eau bout, plus elle condense de vapeurs, ou inversement*"—the italics are mine. Can any reader kindly explain by what law of caloric this takes place, if it does take place, which I doubt. It certainly does not occur on a large scale as in rectifying large quantities of coal-tar benzols.—I am, &c.,

W. W. Staveley.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 6, August 9, 1880.

Experiments on the Discharge in a Rarified Medium.—A. Righi.—If whilst a Crookes's tube (*e.g.*, one of those where the negative electrode is cylindrical or spherical) is illuminated with a Ruhmkorff's coil a conductor communicating with the negative electrode is brought near the glass, and at the same time the discharge is made by means of a magnet to bend towards the same side of the tube, we perceive that a dark spot is produced in the midst of the green fluorescence, where the glass is charged negatively. It seems then that the glass becomes luminous at the point where it acts as a positive electrode. The same appears from the following experiments:—One of these tubes is isolated by means of long threads of silk, and a ball communicating with the positive conductor of a Holtz machine is brought near to its side. The electrodes of the tube diffuse positive electricity in the air, whilst negative electricity is diffused by a point applied to the conductor. The green fluorescence appears on the electrised side of the tube, which acts as the positive electrode in the internal discharge. The author approached the same ball or a metallic point to the side of a small cylindric Geissler's tube containing phosphorescent calcium or strontium sulphide. The powder becomes very

strongly luminous opposite to the ball if this is negative, but very slightly if it is positive. If the ball is negative and is placed near the extremity of the tube, so that one of the electrodes is between the ball and the powder, the shadow of the electrode is distinctly projected upon the powder. We thus obtain in a common Geissler tube one of the striking phenomena described by Mr. Crookes. The pale blue or violet light which fills Crookes's tubes is strongly influenced by the hand or by conductors brought near to the tube. The author connected the electrodes of the tube with the conductors of the Holtz machine (without condensers), arranging an interruption where sparks might pass over, and alternately approached to it isolated balls, communicating with the two electrodes. He always found that the light due to the discharge is attracted by the positive and repelled by the negative ball, that is the discharge acts like a body negatively electrified. Mr. Crookes has shown that every isolated conductor introduced into one of his tubes becomes charged positively. The following experiment may explain this phenomenon:—If whilst the current of a Holtz machine is passed into a long Crookes tube, there is presented to it at a right angle by one of its electrodes a small Geissler tube, the other electrode of which is held in the hand, a discharge is seen in the latter tube directed from the long tube towards the hand. If the potential of the positive conductor is reduced to zero the small tube becomes dark, but is traversed by the discharge if we touch the negative conductor. It seems, then, that the long tube almost entirely has a potential differing little from that of the positive electrode, and that near the negative electrode a very great fall of the potential takes place. It is therefore probable that during the discharge the negative electrode becomes heated much more than the positive. This the author thinks is proved by the following experiment:—The induced discharge of a coil is passed into the electric radiometer, holding it in such a manner that the vanes may not turn. The discharge is then interrupted and the apparatus placed in its normal position, taking care not to shake it, so as to make it turn in the ordinary direction, or to give it a negative rotation. Soon the mill begins to turn in the same direction, and almost with the same speed as if still traversed by the discharge. The cause which makes the radiometer turn is probably the heat evolved when the discs act as a negative electrode. Hence the cause of the mechanical actions peculiar to the negative electrode will be the same as in the radiometer. The electric force of the negative electrode upon the molecules which depart from it negatively charged, tends to give them a direction normal to the surface of the electrode. When they impinge upon the glass they are discharged, and the glass becomes luminous. We often see, in fact, discharges passing from the positive electrode to the fluorescent portions of the glass.

Certain Properties of Flames.—M. Meyreneuf.—A flame produces upon the jet that feeds it two contrary effects, which in general do not compensate each other. It occasions an afflux of gas by the current of expanded products which rise above it, and at the same time a repulsion from the expansion due to the combustion. Either of these effects may be made to predominate by modifying the size of the orifice. Repulsion predominates in flames of distinctly conical outline and afflux in cylindrical flames.

Refraction-Indices of Aqueous Solutions of Acetic Acid and Sodium Hyposulphite.—M. Damien.—The point of solidification of the acetic acid employed was 16·7°. From 20°—8° the indices varied per degree by about 0·0004. A graphic representation of the results shows that the variations of the coefficient A and those of the density d are quite analogous. The author represents the refringent power of a body by $\frac{A-1}{d}$. His experiments confirm the empirical law of Landolt and Wüllner. For one and the same body the expression $\frac{A-1}{d}$ is constant, independent of the temperature and the refrangibility of the light.

An Improvement Introduced in Bunsen's Battery by M. Azapis.—M. Ducretet.—This improvement consists essentially in substituting for the acidulated water in contact with the zinc, a solution, at 15 per cent of potassium, of caustic potassa, common salt, or sal-ammoniac. The intensity of the current is not inferior to that of Bunsen's battery, the zinc does not require to be amalgamated, it wears less, and the constancy of the current is remarkable.

Researches on the Combustion-heats of Certain Bodies of the Fatty Series.—W. Louguinine.—The compound of which the author treats is aceto-acetic ether.

Spectra of Ytterbium and Erbium.—R. Thalén.—M. Marignac discovered, in 1878, that the earth previously called erbia is in reality a mixture of two distinct earths: the one white, to which he gave the name ytterbia, and the other of a pure rose colour, presenting well-marked absorption-bands, *erbia*. A new spectral examination of these bodies became, therefore, requisite, and was undertaken in 1879 by M. Lecoq de Boisbaudran, as far as ytterbia is concerned. On submitting the aqueous ytterbium chloride obtained by M. Marignac to the action of the induction-spark, he found that the spectrum of ytterbium consists chiefly of bands, grouped between the solar rays D and F, and almost all shaded from the red towards the violet. But in conformity with views generally admitted the spectra of simple bodies do not consist of degraded bands, but of rays perfectly distinct; we are therefore led to think that the induction-spark used by M. Lecoq de Boisbaudran was not sufficiently powerful, and that in consequence the spectrum observed by him should be ascribed to the chloride or oxide but not to the metal itself. The author proceeds to describe the results of the spectroscopic examination of ytterbium chloride obtained by M. Nilson. By this examination he has found that the spectrum of ytterbium is a spectrum of rays, and that these rays are with slight exceptions identical with those formerly ascribed to erbium by M. Höglund. Thus it may truly be said that the spectrum of ytterbium has been observed and compared with the solar spectrum five years before chemists had succeeded in separating this body. For the positions of the rays in question the reader is referred to the plate in the *Journal de Physique*, iv., p. 33 (1875). The author, however, subjoins the wave-lengths of the principal rays due in his opinion to ytterbium. The emission spectrum of true erbium remains to be determined. By means of erbium chloride prepared by M. Clève the author ascertained the principal rays of this metal, but they are in general rather faint. Among the rays due to erbium there are only three which can be found in the erbium-spectrum of Höglund above-mentioned, all the others being completely new. It must be added that the chemical product is not absolutely pure, but mixed with a little ytterbium, as is proved by the presence of the ray 6221 in the spectrum of the body under examination. We see then that one of two bodies mixed in Höglund's so-called erbium, *i.e.*, ytterbium, has appropriated almost all the brilliant rays observed by the author in 1873, whilst the other, true erbium, retains but a very small number. In return the latter body possesses beside the new brilliant rays which the author points out, not merely the well-known absorption-bands, but also the spectrum of luminous bands observed on igniting its oxide in the flame of a gas blowpipe. On repeating Bahr's experiment upon the emission-spectrum, he finds that this latter spectrum belongs exclusively to erbia and not to ytterbia, which might have been foreseen on recalling the fact observed by M. Bunsen in 1866, that the black absorption-bands coincide exactly with the luminous bands mentioned. The wave-lengths of the chief rays of the emission-spectrum due to erbium are given in the subjoined table, the numbers being only approximate. In fact, by reason of the feeble intensity of the rays of erbium, the author could employ only three flint-glass prisms, each of 60°.

Ytterbium.

Wave-length.	Intensity.	Wave-length.	Intensity.
6463·0	5	5476·0	1
6274·0	5	5447·5	4
6221·0	1	5431·5	4
6159·5	4	5352·0	1
6151·5	4	5346·5	2
6004·0	3	5345 0	2
5990·0	4	5334·0	1
5983·5	3	5300·0	4
5994·0	4	5279·0	4
5836·0	3	5257·0	4
5818·0	3	4993·5	4
5770·0	4	4935·0	3
5718·5	4	4785·5	2
5651·0	4	4725·0	2
5587·5	4	4575·5	4
5555·5	1	4518·0	4

Erbium.

Wave-length.	Intensity.	Wave-length.	Intensity.
6076·0	4	4951·0	2
5881·0	4	4899·0	2
5871·0	4	4871·5	3
5826·0	2	4830·0	4
5762·0	3	4819·0	3
5756·0	4	4794·5	4
5485·0	4	4674·0	2
5343·5	3	4605·5	2
5256·0	2	4500·5	3
5217·0	3	4419·0	4
5188·0	3	4252·5	4
5164·0	4		

On Thulium.—P. T. Clève.—The author has announced a year ago that the old erbia contains three earths having absorption-spectra, the metals of which he named thulium, erbium, and holmium, the latter being identical with M. Soret's X, but not with M. Delafontaine's philippium. Thulia, which is found in the fractions between ytterbia and true erbia, is very difficult to isolate, especially as it is present in the crude earths in a very small proportion. The author has nevertheless succeeded in extracting it in a state of purity sufficient to place its existence beyond a doubt. This earth is white and its salts are colourless, like those of ytterbia, but their solutions present to the spectroscope two absorption rays which do not appear in the spectrum of pure erbia, *i.e.*, a ray in the red part ($\lambda = 6840$) very strong, and one in the blue part ($\lambda = 4645$) which is very broad in concentrated solutions rich in thulia. The molecular weight of the fraction richest in thulia which the author has been able to obtain is 129·6 (RO), but this fraction contained a small proportion of erbia, which might reduce the molecular weight by 0·2. As the earth contained also a quantity of ytterbia impossible to estimate the number 129·8 is to be regarded merely as a maximum. The maximum atomic weight of thulium is 170·7, if we accept the formula Tm_2O_3 for the oxide. A mixture of ytterbia and erbia, the molecular weight of which (RO) should be 129·6, ought to be strongly red, and its solution should display the absorption rays of erbia very distinctly, which is not the case with the fraction described. The existence of thulium is still better proved by its spectroscopic characters, which M. Thalén has examined and which he will describe in a future communication.

Secondary Reaction between Sulphuretted Hydrogen and Sodium Hyposulphite.—F. Bellamy.—On boiling a solution of bisodic sulphite with soluble sulphur in order to obtain sodium hyposulphite, nothing particular is perceived during ebullition, and the filtrate, on standing, deposits crystals of hyposulphite and remains clear. With insoluble sulphur an odour of sulphuretted hydrogen is given off during boiling, and the liquid sometimes becomes opalescent; when set to crystallise after filtration it continues to give off sulphuretted hydrogen, becomes turbid and milky, and deposits along with the crystals a considerable quantity of white sulphur. Boiling sodium sulphite dissolves insoluble sulphur in a larger proportion than soluble.

Acid Obtained by M. Boutroux in the Fermentation of Glucose.—M. Maumené.—The author points out that he described hexenic acid in his "Traité Théorique et Pratique de la Fabrication du Sucre."

A New Process for Producing Malleable Nickel of Different Degrees of Hardness.—J. Garnier.—Melted nickel is rendered brittle by holding a larger or smaller quantity of oxygen in solution. The author succeeds in removing this oxygen by the addition of phosphorus. Nickel containing not more than 3-100oths of phosphorus is soft and malleable, but above this dose its hardness increases at the expense of its malleability. One method used by the author for incorporating the phosphorus consists in adding to the melted metal in suitable proportion a nickel phosphide, obtained by melting together a mixture of calcium phosphate, silica, coke, and nickel.

On Propyl-neurine.—H. G. Morley.—The author prepares this compound by causing trimethyl-amine to react upon propylenic chlorhydrine.

Chemisches Central-blatt.
No. 15, 1880.

Constitution of so-called Nitrous Vapours and their Preparation.—O. N. Witt.—The author concludes, in opposition to Lunge, that nitrogen trioxide, N_2O_3, does not exist as such in a gaseous state, and that in the very moment of its formation it is resolved into a mixture of nitrogen di- and tetroxide, having the same percentage composition, but not the same constitution.

Vanadium in Commercial Caustic Soda.—E. Donath.—If the aqueous solution of certain commercial sodas is supersaturated with sulphuretted hydrogen the liquid takes a cherry-red colour from the formation of a sulpho-vanadiate.—*Polyt. Journal.*

Phosphates and Arseniates of Zinc and Cadmium.—W. Demel.—*Vienna Sitzungsberichte.*

Certain Cobalti-cyanide Compounds.—J. Schüler.—The author describes lead cobalti-cyanide and its combinations with lead hydroxide, and lead nitrate and potassium and ammonium lead cobalti-cyanides.—*Vienna Sitzungsber.*, 79, 2 abt., 302-319.

Specific-heat of Uranous-uranic Oxide and Atomic Weight of Uranium.—J. Donath.—The specific-heat in question is 0·07979, and that of uranium, 0·0497. The atomic weight is 120.—*Vienna Sitzungsber.*, 79, 2 abth., 699-704.

The Albuminoids of Various Oil-seeds.—H. Ritthausen.—Not capable of useful abridgment.—*Pflüger's Archiv.*, 21, 81-104.

Formation of Fats in the Lower Fungi.—C. v. Nägeli and O. Loew.—The chemical nature of the food of the fungi seemed to be almost without influence upon the formation of fatty matter.—*Bayr. Akad. d. Wissenschft.*

Value of Nitrogenous Manures in the Development of Plants.—V. T. Magerstein.—The best experimental results were obtained with urea; then followed potassium nitrate, and then ammonium sulphate. Plants confined to atmospheric nitrogen only remained backward in their growth.—*Listy Chem.*, 4, 74-76.

Metha-emoglobine.—F. Marchand.—If blood is mixed with potassium chlorate an absorption-band gradually appears, near that of hæmatine, but nearer to the green of the spectrum. It belongs to methæmoglobine, a substance obtained from hæmoglobine, by gentle oxidation and capable of being re-converted into hæmoglobine by reducing agents, such as ammonium sulphide.—*Virchow's Archiv.*, 77, 489.

A Method of Determining the Topography of Chemical Processes in the Animal System.—W. Kochs.—Small quantities of hippuric acid were formed on digesting blood along with sodium benzoate and glycocoll for some hours at 35° to 40° with finely cut kidney. The question was then whether this synthesis depended on the vitality of the cells. Portions of kidney were therefore exposed for two hours to a temperature of −20°. When they were again thawed and comminuted the synthesis could no longer be effected. No hippuric acid was formed if the blood was digested with sodium benzoate and glycocoll without kidney. Nor could the synthesis be effected with portions of liver.—*Pflüger's Archiv.*, 20, 64.

Influence of Light upon the Development of Animals and their Metamorphosis of Matter.—S. L. Schenck.—Light increases the evolution of carbonic acid and the absorption of oxygen. It acts not merely through the eyes but through the whole surface.—*Untersuch. zur Naturlehre des Menschen und der Thiere*, 12, 266.

Fluctuations of Urea in the Urine in Consequence of Irritation of the Liver by the Electric Current.—M. Stolnikow.—Electric irritation of the liver strikingly increases the secretion of urea. Recent liver comminuted and mixed with fresh defibrinised blood yielded much urea after exposure for an hour to an induction-current. Without the current a mere trace was obtained.—*Petersburg Med. Wochenschr.*, 1879.

Destiny of Ammonia in Healthy Persons, and Source of Sugar and Behaviour of Ammonia in Diabetic Patients.—A. Adamkiewicz.—In experiments with sal-ammoniac the ammonia disappeared from the system, probably as urea. Sal-ammoniac increased the decomposition of the albuminoids. Diabetic patients form sugar from the albuminoids. The injestion of sal-ammoniac diminishes the excretion of sugar.—*Virchow's Archiv.*, 76.

No. 16, 1880.

Gluconic Acid.—M. Hönig.—To obtain this acid in quantity the author treats grape-sugar with bromine and water in Champagne bottles, mixes the liquid obtained with elutriated cuprous oxide, with constant stirring till the precipitate of cuprous bromide takes a distinct red colour, filters quickly, and passes sulphuretted hydrogen into the filtrate. After filtering off the copper sulphide the liquid is gently heated to expel sulphuretted hydrogen, treated with silver oxide to remove hydrobromic acid, filtered, and again treated with sulphuretted hydrogen.—*Vienna Sitzungsberichte*, 78, 2 Oct.

A New Isomer of Gluconic Acid.—M. Hönig.—An account of the preparation and properties of paragluconic acid.—*Vienna Sitzungsber.*, 80, 2 abth.

Detection of Mercury.—M. Jüptner.—The scarlet modification of mercuric iodide in the light of a spirit lamp with sodium chloride placed upon the wick appears perfectly white. No other pigment possesses the same property.—*Oest. Zeitung*, 28, 92.

Determination of Urea.—E. Pflüger.—Liebig's method of titration with mercuric nitrate may give errors of 14 per cent. The author shows how such are to be avoided.—*Pflüger's Archiv.*, 21, 248.

Examination of Potassium Iodide and Bromide and Hydrobromic Acid. Detection of Chlorine, Iodine, and Bromine.—H. Hager.—At common temperatures silver iodide is almost insoluble in 10 per cent ammonia, whilst silver bromide and chloride are soluble; silver bromide and iodide are insoluble in cold solution of ammonium, 15 to 17 per cent; silver chloride dissolves in this solution.

No. 17, 1880.

Sulphur Compounds of Chromium.—Max Groeger.—A mixture of chromium hydroxide and sulphur, ignited in a current of hydrogen, yields a chromium sulphide, Cr_3S_4. The chromites, if treated in the same manner, yield corresponding sulphur compounds. All these sulphides are insoluble in water and in hydrochloric acid, but dissolve with oxidation in nitric acid or *aqua regia*.—*Wien. Anzeiger*, 1880, 62.

Photo-Chemistry of Silver.—J. M. v. Eder.—Oxidising acids are decidedly injurious to the sensibility to light; other acids less so, and alkaline chlorides and bromides in a much smaller degree. Alkalies increase the sensibility to light.—*Wien. Anzeiger*, 1880, 45.

Animal Tar.—H. Weidel and G. L. Ciamician.—On distilling gelatin free from fatty matter the authors obtained no nitriles of the fatty acids, but large quantities of ammoniacal salts along with pyrrol, homo-pyrrol, and other members of this series, besides a spendidly crystallised body, pyrocall, $C_{10}H_6N_2O_2$.—*Wien. Anzeig.*, 1880, 62.

Aldehyd Resin.—G. L. Ciamician.—On treatment with zinc-powder there is obtained from 30 to 40 per cent of a hydrocarbon mixture consisting of ethyl-benzol, meta- and para-ethyl-toluol, and methyl-naphthalin.—*Wien. Anzeiger*, 1880, 46.

Cinchomeronic Acid.—H. Skraup.—Pyridin-tricarbonic acid, an oxidation-product of cinchonic acid, if carefully heated to 120° to 125°, is resolved into carbonic acid and pyridin-dicarbonic acid, which is identical with cinchonic acid.—*Wien. Anzeiger*, 1810, 46.

Decomposition of Nitro-sulph-hydantoin with Bases, and on Nitroso-thio-glycolic Acid.—R. Andreasch.—The most dilute solution of nitroso-thio-glycolic acid in water gives a splendid dark blue colour with ferric chloride.—*Wein. Anzeiger*, 1880, 42.

On α-Ethyl-phenol.—W. Suida and S. Plohn.—This ethyl-phenol is identical with the ethyl-phenol obtained by Ciamician on distilling gum ammoniac with zinc-powder.—*Wein. Anzeiger*, 1880, 40.

Oxycuminic Acid.—E. Lippmann and R. Lange.—The authors have analysed several salts of this acid.—*Wein. Anzeiger*, 1880, 48.

The Tannic Acid of Oak-bark.—C. Etti.—Already noticed.

Chemiker Zeitung.
No. 17, April 22, 1880.

Manufacture of Bone-black.—O. Cordel.—This paper deals rather with the economic political phase of the manufacture than the chemical processes involved.

Barff's Process for Protecting Iron from Rust.—This paper does not admit of useful reproduction without the accompanying illustration.

The Removal of the last Traces of Sulphuric Acid after Refining Petroleum.—H. Perutz.—Caustic alkali is used in this process, as sodium carbonate does not remove the free sulphur. The author has succeeded in effecting this operation by means of soda-lime. He obtains his oils free from pyren and chrysen, as well as from pyrogenous resins. Both chrysen and pyren can be easily nitrised, and will certainly play a part in the colour industry. Petrocen, a green colouring-matter, prepared in America from petroleum residues, could doubtless be obtained from them.

Presence of Alcohol in Animal Tissues.—J. Béchamp.—Alcohol and acetic acid are constant and necessary products of putrefaction. The author has also discovered alcohol in small quantities in normal and quite recent animal tissues, a fact which should be remembered in chemico-judicial investigations.—*Ann. Chim. Phys.*, xix., pp. 406—421.

The Ultra-violet Rays.—J. L. Schönn.—The author has examined the ultra-violet spectra of cadmium, zinc, thallium, indium, manganese, iron, and aluminium.—*Wiedemann's Ann. Phys. Chem.*

No. 18, April, 1880.

Physical Isomerism and its Importance in Chemical Research.—The author points out that the phenomena

of polymorphism, allotropy, &c., meet with their simplest explanation in the assumption of different molecular magnitudes in the bodies which present such modifications. The molecules of ammonium nitrate condensed at 168° are simpler than those condensed at 127°. At the latter temperature, the molecules of the first kind have united together to form larger totals, and heat is liberated. Monoclinar sulphur bears to the rhombic form a similar relation to that of acetylene to benzol.

Practical Results with Haupt's Gas Furnace.—A. Ziegler.—This memoir cannot be usefully produced without the accompanying illustration.

Certain Ultramarine Compounds (a continuation).—Karl Heumann.—From *Annalen der Chemie.*

MISCELLANEOUS.

New Gas Heating Burner.—We have recently been using a new gas heating burner made by Mr. Thomas Fletcher, of Warrington, which is specially adapted for many laboratory purposes. It has from three to four times the power of any burner similar in appearance. The flame is *solid*, intensely hot, and perfectly free from smell. It cannot be damaged by the dirtiest work. In case the perforated copper dome gets choked with dirt, it can, when the burner is warm, be lifted off and washed or brushed clean. Any liquid spilt so as to get inside the burner flows out by the side tube without the possibility of damaging the burner. The body of the burner is cast all in one piece without a joint, thus doing away with one great fault, causing liability to leakage in most of the burners at present in use.

The Hollway Process in Queensland.—We learn from the *Gympie Times* that Mr. Joseph, of the Gympie Pyrites Works, has been for some time past experimenting in the endeavour to save the gold from "mill refuse." The new appliances consist of apparatus for practically putting into operation the recent discovery of Mr. John Hollway, whereby metallic sulphides are reduced without the aid of external fuel. Coal and wood have hitherto been used as fuel for producing heat in smelting operations. Mr. Hollway now proposes to supply their places by using up the sulphur contained in the pyrites to be operated upon, by simply forcing a current of air through numerous jets (somewhat after the Bessemer principle) with a mass of molten pyrites, whereby sufficient heat is developed and the operation is made self-supporting without the aid of other fuel than a little coke, which is required to start the furnace, and which stands in the same relation to the ore as wood does to coal in lighting an ordinary fire. The process is simplicity itself, the only wonder being that its discovery has been so long delayed. It is generally known that pyrites catches fire when roasted in a current of air; and all Mr. Hollway suggests is to give it more of that inexpensive element when sufficient heat is produced to cause the pyrites to fuse. Messrs. Dudley and Rutter have already erected at Mr. Joseph's works the engine to produce the blast, and all that now remains to be done is to finish the erection of the furnace, when this novel invention will have a trial on the products of our district, about the ultimate success of which Mr. Joseph seems sanguine. At the same time he is not without some anticipation of having to spend much time and labour in bringing the matter to a perfectly successful issue. In an economical point of view, our readers will readily perceive that if ores can be expeditiously melted without the aid of any other fuel than such as is merely required to move the steam engine, a great saving of expense is probable to ensue. The process is applicable to copper and other metals as well; indeed, Mr. Hollway is now erecting works for treating the first-named ores in other parts of the world, and should the process prove itself as meritorious as its inventor claims it to be, its use can doubtless be turned in a similar direction in this country with immense advantage to mining generally.

Les Mondes, Revue Hebdomadaire des Sciences. No. 11, August 5, 1880.

This issue contains no physical or chemical matter which has not appeared elsewhere.

NOTES AND QUERIES.

Soft Water.—I am in search of a local in the vicinity of London where I can obtain *soft* water. Can you or any of your correspondents give me an idea in what district of London, or within 50 miles thereof, I am likely to obtain the same.—"D. D."

THE JOURNAL OF SCIENCE

for OCTOBER (Price 1s. 6d.), includes—

The Vehicle of Force. By Charles Morris.
Exploration in the Far East.
The Phenomena of Fluorescence. By E. R. Hodges.
Gilbert White Reconsidered.
The Four Forces in Nature. By G. Whewell, F.I.C.

Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

CITY AND GUILDS OF LONDON INSTITUTE FOR THE ADVANCEMENT OF TECHNICAL EDUCATION.

WINTER COURSES OF

LECTURES AND LABORATORY INSTRUCTION

At the temporary Classrooms of the Institute,

COWPER STREET, FINSBURY,

Commencing October 4th, 1880.

By Professor ARMSTRONG, Ph.D., F.R.S.—
Organic Chemistry, with Industrial Applications—Mondays, 6.30 to 9.30 p.m.
Photographic Chemistry—Wednesdays, 6.30 to 9 p.m.
Inorganic Chemistry—Tuesdays and Fridays, 4 to 5 p.m.

By Professor AYRTON, A.M., Inst. C.E.
Electrical Instrument Making—Tuesdays, 6.30 to 9.30 p.m.
Weighing Appliances and Motor Machinery—Fridays, 6.30 to 9.30 p.m.
Electric Light—Mondays and Wednesdays, 4 to 5 p.m.

FEE for each of the above Courses .. .. .. 5s.

Laboratories open daily from 10 to 1 and from 2 to 5.
Detailed Prospectuses to be had on application to the Professors at Cowper Street Schools; or to

PHILIP MAGNUS, Director and Secretary.
Gresham College, Basinghall Street, E.C.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.
The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.
Especial facilities or persons preparing for Government and other examinations.
Private Pupils will find every convenience.
Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.
Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

MR. J. S. MERRY,

ASSAYER AND ANALYTICAL CHEMIST,

SWANSEA.

ROYAL POLYTECHNIC.—Asmodeus, the Bottle Imp. Ventriloquism and Magic, by Professor Hellis. Modern and Machine Guns, the New Forest, the Oxy-hydrogen Microscope, &c., by Mr. J. L. King. Musical Entertainment by the talented Adison family. Sights of London, by Mr. Heath. Blondin and Leotard, the marvellous Automata. Diving Bell, Moving Machinery and Models. The Royal Polytechnic Barometer, &c. Stokes on Memory, Tuesdays and Thursdays at 7. Open 12 till and 7 till 10. Admission 1s.

GREENBANK ALKALI WORKS COMPANY (LIMITED), ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{3}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

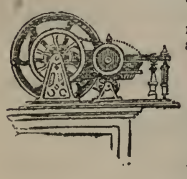
Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

THOMAS ADKINS & CO., SMETHWICK, NEAR BIRMINGHAM

MANUFACTURERS OF SPECIALLY PREPARED RED LEAD FOR FLINT-GLASS MAKING.

Carr's Patent Paint and Drug Mill.

Approved by some of the most eminent Chemists, and awarded the Silver Prize Medals of the Manchester and Liverpool, and the Middleton Agricultural Shows.



From Messrs. E. H. SMYTH & Co., 21, Duke Street, Edinburgh, and 69, Coleman Street, City, London.—The small Levigator Mill we recently got from you works most efficiently, and is a great economiser of time.

The chief feature in this machine is, that although it can be turned with ease by a boy, it has immense frictional power for levigating purposes. This is caused by the runner being driven at a much greater speed, but in the same direction, than the bowl. The surfaces being Minton ware, they are clean, smooth, and durable.

Testimonials on application.

£11 nett cash, delivered in Manchester.

The diameter of the bowl is 18 ins., and it and the runners are made of Minton ware. It is useful for Painters, Chemists, Grocers, and Cooks, for triturating and mixing Medicines, Vegetable Powders, Ointments, Paints, Sugar, Salt, Spices, Herbs, Meat for Potting, and will grind the COARSEST EMERY INTO A NEARLY IMPALPABLE POWDER in a few seconds. The pan can be tilted for emptying, as shown in the dotted lines; it can be worked by hand or power.

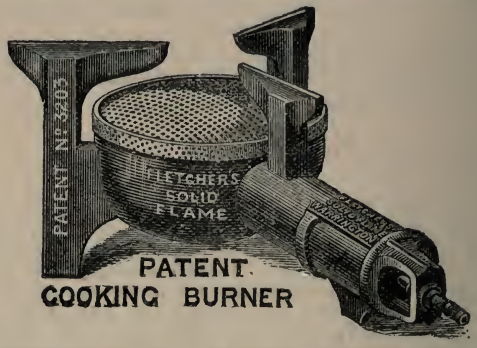
SOLE MAKERS—
W. H. BAILEY & Co., Albion Works, Salford, Manchester.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

FLETCHER'S
PERFECTED SOLID FLAME GAS COOKING AND HEATING BURNER.

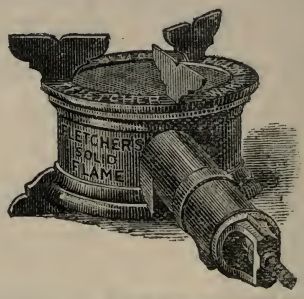
PATENTED AUGUST, 1880.

The only perfect Burner for Cooking, Boiling, and Dirty Laboratory Work. Free from smell, the most powerful Burner known, and not damaged by the roughest, dirtiest work. This Burner is a valuable improvement on Fletcher's well-known Solid Flame Burner, of which



thousands are in daily nse. The Gauze is done away with and replaced by a loose perforated Dome of Solid Copper, which can be taken off and cleaned when choked with dirt. The Stand is broad and firm, supporting large or small vessels safely and steadily.

PRICE, Japanned, 6s. 6d.; Nickel Plated, 8s. 6d.



ORIGINAL SOLID FLAME BURNER, with Gauze
Price, Bronzed, 4s.; Nickel Plated, 5s.

All these Burners are the same power, and will with equal ease Boil an Egg, Cook a Chop, Boil a Kettle, or Melt half a hundredweight of Lead in an Iron Pot. They will Boil half a gallon of Water in a Flat Copper Kettle in Six Minutes, and work equally well with Air Gas or Coal Gas.

GAS FIRE.

An attachment to the above making a first-rate Gas Fire is in preparation. Complete Illustrated List, Price 3d., of Gas Furnaces for Crucibles, Muffles, Ladles, Porcelain, Painting, &c.; Hot and Cold Blast Blowpipes; Foot, Hand, and Automatic Blowers, Ingots Moulds, &c.; with reprint of Mr. Fletcher's Lecture to the Society of Arts on *The Application of Gaseous Fuel to Laboratary Work*, for which he was awarded the Society's Silver Medal in June, 1880.

THOS. FLETCHER,
4 & 6 MUSEUM STREET, WARRINGTON.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

JESSE FISHER & SON,
Phœnix Chemical Works Ironbridge.

THE CHEMICAL NEWS.

VOL. XLII. No. 1090.

FURTHER NOTES ON PETROLEUM SPIRIT AND ALLIED LIQUIDS.*

By ALFRED H. ALLEN.

AT the Sheffield meeting of the Association, I laid before the Section the results of some experiments for distinguishing commercial petroleum spirit or "benzoline" from coal-tar naphtha or benzene. I have since extended the experiments to the "shale naphtha," obtained as a secondary product of the manufacture of paraffin wax and burning oil from the bituminous shale of the south of Scotland. In physical properties shale naphtha presents the closest resemblance to petroleum spirit, both liquids being known in commerce by the same names and used for similar purposes. They are also usually stated to be identical in chemical composition, and hence I supposed that the reactions which I had found characteristic of petroleum spirit would be equally applicable to shale naphtha. Experiment has shown certain differences in the behaviour of the two liquids with reagents which point a much wider divergence in their chemical composition than is commonly suspected to exist.

The following table exhibits in a convenient form the physical characters of the volatile naphthas from petroleum, shale, and coal-tar, together with the differences observed in their solvent action on coal-tar pitch and anhydrous crystallised carbolic acid.

	Petroleum Spirit.	Shale Naphtha.	Coal-tar Naphtha and Benzol.
a. Leading constituents.	Heptane, C_7H_{16}, and its homologues.	Heptylene, C_7H_{14}, and its homologues.	Benzene, C_6H_6, and its homologues.
b. Sp. gr. of sample at 15·5° C.	0·690	0·718	0·876
c. Boiling-point of sample.	55° C.	56° C.	80° C.
d. Solvent action of the sample on coal-tar pitch.	Very slight solvent action. Liquid only coloured amber-yellow, even after very prolonged contact.	Behaves similarly to petroleum spirit.	Readily dissolves pitch, forming a deep brown solution.
e. Behaviour of the sample on agitating 3 measures of it (cold) with 1 measure of fused crystals of absolute carbolic acid (Calvert's No. 2).	No apparent solution. The liquids are not miscible.*	The liquids form a homogeneous mixture.	The liquids form a homogeneous mixture.

* For further details of this reaction see Allen's "Commercial Organic Analysis," i., 317.

From this table it appears that while shale naphtha presents the closest resemblance to petroleum spirit as regards its specific gravity, boiling-point, and solvent action on pitch, it is sharply distinguished from it by its behaviour with carbolic acid, in which respect it resembles coal-tar naphtha or benzene. The carbolic test is not applicable to mixtures of the various products, as in such cases the phenol passes readily into complete solution. In its limited solubility in rectified spirit, shale naphtha resembles petroleum spirit, and differs from benzene, which is miscible with alcohol in all proportions.

As the carbolic acid test had shown a sharp distinction between the more volatile products from petroleum and those from bituminous shale, it appeared interesting to apply it to the burning-oils obtained from different sources. The samples of burning-oil compared were a specimen of American petroleum, or "kerosene," of 0·800 sp. gr., boiling at 166° C., and one of shale oil, or "photogene," of 0·801 sp. gr., boiling at 170° C. Both samples required 16 or 17 volumes of methylated spirit for complete solution, and gave with coal-tar pitch light yellow liquids, having a greenish fluorescence. Carbolic acid, employed in the proportion already described, was found not to be miscible with either kind of oil in the cold, but the petroleum product caused it gradually to assume a deep purple and ultimately a black colour. This reaction was repeatedly obtained, but I am unable to say whether it is peculiar to the few specimens hitherto examined, or is a test which might be generally applied to distinguish petroleum kerosene from the similar product from shale.

Correspondence with a friend engaged in the paraffin industry, and to whom I am indebted for much information and various samples of shale products, gave me the clue to the differences observed in the behaviour of shale oils and petroleum oils with reagents. The explanation lies in the fact that while the naphtha and burning-oil obtained by the distillation of petroleum consist chiefly of hydrocarbons of the marsh-gas or paraffin series, having the general formula $C_n H_{2n+2}$, the similar products of the distillation of shale consist largely of hydrocarbons of the ethylene or olefine series, having the general formula $C_n H_{2n}$. This difference in composition is clearly indicated by the behaviour of the various liquids with fuming nitric acid and with bromine. Thus, while 100 measures of petroleum spirit when treated with fuming nitric acid (sp. gr. 1·45), concentrated sulphuric acid, fuming sulphuric acid, and caustic soda, employed successively, yields at least 75 measures of unchanged oil, shale naphtha on similar treatment leaves but 15 to 30 per cent of paraffins. Similar differences are observable in the case of the burning-oils, that from petroleum yielding from 55 to 80 per cent of paraffins, while from shale photogene the unchanged oil is only 35 to 40 per cent. Repetition of the experiment shows that the process is capable of yielding results agreeing within 2 or 3 per cent, and sometimes much closer.

The different susceptibility of petroleum and shale oils to the action of nitric acid is borne out by the difference in the facility with which they combine with bromine. The results obtained in this way are very remarkable, and conclusively show the predominance of olefines and other unsaturated hydrocarbons in shale products, these readily decolourising many times the volume of bromine which can be caused to combine with petroleum naphtha or burning-oil. I have strong hopes of basing a simple quantitative method on this well-known principle.

In petroleum spirit I have repeatedly found traces of benzene and its homologues, as indicated by the production of aniline. Shale products, however, appear to be wholly destitute of this series of hydrocarbons. I am informed that while chrysene is produced largely by the

* A paper read before the Chemical Section of the British Association, Swansea Meeting, 1880.

distillation of shale, anthracene is met with in but very insignificant quantity, and naphthalene appears to be entirely absent. The lubricating oils produced from shale consist almost wholly of olefines, the paraffins of high boiling-point being solid at ordinary temperatures, and hence they are separated in the form of paraffin wax.

The following table shows roughly the differences in chemical composition between commercial petroleum products and the bodies of similar physical characters obtained by the distillation of shale, as deduced from the action of nitric acid on the oil.

Product.	Petroleum.	Shale.*
Naphtha or spirit; sp. gr. about 0·700; boiling-point about 56° C.	At least 75 per cent of hydrocarbons of the paraffin or marsh gas series, $C_n H_{2n+2}$. The remainder olefines, $C_n H_{2n}$, with distinct traces of benzene and its homologues.	At least 60 to 70 per cent of hydrocarbons of the olefine or ethylene series, $C_n H_{2n+2}$. The remainder paraffins, $C_n H_{2n+2}$. No trace of benzene or its homologues.
Photogene or burning-oil; sp. gr. about 0·800; boiling-point about 160° C.	55 to 80 per cent of higher members of the paraffin series, $C_n H_{2n+2}$. The remainder chiefly olefines.	60 to 65 per cent of higher members of the olefine series, $C_n H_{2n}$. The remainder paraffins, $C_n H_{2n+2}$.
Lubricating oil.	(?)	Almost wholly higher olefines, $C_n H_{2n}$, the paraffins of similar high boiling-point being solid. No naphthalene.
Wax.	Solid paraffins, $C_n H_{2n+2}$.	Solid paraffins, $C_n H_{2n+2}$.

* Since this paper was written, I have found reason to question the accuracy of the quantitative results here given. But whatever be the true proportion of unsaturated hydrocarbons, they are present in far larger quantity in the shale than in the petroleum products.

ON THE ACTION OF OILS ON METALS.*

By WILLIAM HENRY WATSON, F.C.S., &c.

At the Plymouth meeting of this Association I brought forward the results of some experiments, showing the actions of various oils on copper, and the conclusions arrived at were briefly these:—

1. That of the whole of the oils used, viz., linseed, olive, colza, almond, seal, sperm, castor, neatsfoot, sesame, and paraffin, the samples of paraffin and castor oils had the least action, and that sperm and seal oils were next in order of inaction.
2. That the appearances of the paraffin and the copper were not changed after 77 days' exposure.
3. That different oils produce compounds with copper varying in colour, or in depth of colour, and consequently rendering comparative determinations of their action on that metal from mere observations of their appearances impossible.

I was disposed to conclude that these experiments would indicate the relative action of the oils on other metals, simply expecting that the extent of action would vary throughout, but that the variations would be proportionate between the different oils.

Since the publication of these results, however, an interesting paper has appeared (*Pharm. Journ.*), "On the Action of Paraffin Oils on Metals," by Dr. S. Macadam. He comes to the same conclusion as myself with regard to their action on copper, but referring to iron, says "it is slightly affected by paraffin oil, and on ten days' contact the oil becomes deeper in colour and throws down a fine ferruginous sediment." Owing to this, I have lately made experiments on the action of the same oils as those previously used on copper, on iron, and the results, which are the subject of this communication, are interesting to me as showing that there is no relation between the action of an oil on copper and the action of that oil on iron; that, in fact, in several instances those oils which act largely on iron, act slightly on copper, while those which act largely on copper act little on iron. Of course the actual extent of action of the same oil (with the exception of paraffin) is greater on copper than on iron.

* Read before the Chemical Section of the British Association, Swansea Meeting, 1880.

In order that the results might be comparable with those obtained from copper, the same quantities of metal and oil were used, viz., a piece of polished iron exposing 8 square inches of surface, this being immersed in 500 grain measures of the oil under examination. The samples thus prepared were kept in glass dishes, and agitated daily during the whole of the exposure, which extended over twenty-four days. The appearances were then noted and determinations of iron made in each by the colorimetric method, using potassium cyanide as the reagent.

In addition to the oils used in my experiments on copper, I also used a sample of refined lard oil, and a special lubricating oil prepared, by the Dee Oil Company near Chester. The following observations were made, after twenty-four days' exposure:—

1. *Neatsfoot.*—Considerable brown irregular deposit on metal. The oil slightly more brown than when first exposed.
2. *Colza.*—A slight brown substance suspended in the oil, which is now of a reddish brown colour. A few irregular markings on the metal.
3. *Sperm.*—A slight brown deposit, with irregular markings on the metal. Oil of a dark brown colour.
4. *Lard.*—Reddish brown, with slight brown deposit on metal.
5. *Olive.*—Clear and bleached by exposure to the light and air. The appearance of metal same as when first immersed.
6. *Seal.*—A few irregular markings on metal. The oil free from deposit, but of a bright clear red colour.
7. *Linseed.*—Bright deep yellow. No deposit or marks on metal.
8. *Almond.*—Metal bright. Oil bleached and free from deposit.
9. *Castor.*—Oil considerably more coloured (brown) than when first exposed. Metal bright.
10. *Paraffin.*—Oil bright yellow and contains a little brown deposit. The upper surface of the metal on being removed is found to have a resinous deposit on it.
11. *Special Lubricating.*—Metal bright. Appearance of oil not perceptibly changed.

The samples were then chemically examined, and the amounts of iron found in them were as follows:—

Neatsfoot oil (English)	0·0875 grain.
Colza ,, ...	0·0800 ,,
Sperm ,, ...	0·0460 ,,
Lard ,, ...	0·0250 ,,
Olive ,, ...	0·0062 ,,
Linseed ,, ...	0·0050 ,,
Seal ,, ...	0·0050 ,,
Castor ,, ...	0·0048 ,,
Paraffin ,, ...	0·0045 ,,
Almond ,, ...	0·0040 ,,
Special lubricating oil	0·0018 ,,

For comparison, the following are the results obtained of the action of these oils on copper, as previously communicated, after exposure of ten days.

	Copper found.
Neatsfoot oil	0·1100 grain.
Colza ,, ...	0·0170 ,,
Sperm ,, ...	0·0030 ,,
Olive ,, ...	0·2200 ,,
Linseed ,, ...	0·3000 ,,
Seal ,, ...	0·0485 ,,
Paraffin ,, ...	0·0015 ,,
Almond ,, ...	0·1030 ,,

Owing to the length of exposure being different in the two series, we cannot fix on the actual differences in the *rate* of action of any of the oils on the two metals. However, it is shown that almond oil, which acted largely on copper, acts very slightly on iron; in fact, with the exception of the paraffin and special lubricating oil (a mineral preparation), it acted less than any of the other oils on iron. The same is shown, as already mentioned, as to the action of various other oils; thus, while sperm oil acts slightly on copper, it acts considerably, compared with the others, on iron. Linseed, seal, castor, almond, and paraffin may be bracketed as having about the same and very little action on iron, while linseed, olive, neatsfoot, almond, and seal have the greatest action on copper.

The Folds, Bolton,
August, 1880.

ON THE IDENTIFICATION OF THE COAL-TAR COLOURS.*

By JOHN SPILLER, F.C.S.

Dyers and others who are in the habit of using the coal-tar colours are familiar with a number of chemical reactions by which the members of the series may generally be classified and identified. Differences are remarked in their relative affinities for various sorts of fibres, some colours being taken up freely by silk, others fixing better upon wool, and some few, like saffranin, exhibiting a special affinity for cotton. Again, as with the yellows, great differences are observed when the operator proceeds to work with a free acid or a weak alkali in the dye-bath. Primrose (naphthaline yellow) requiring the former, but not so with phosphine (crysaniline yellow), which demands a neutral or even slightly alkaline bath.

By the study of these conditions, aided by a few characteristic tests, it is often possible to identify colouring-matters of unknown or doubtful origin, and it is with the view of extending the number of such readily available tests that I recommend a more frequent appeal to the colour reactions with sulphuric acid.

For this purpose but small quantities of material are required, a few grains serving to impart a distinct colour to a comparatively large bulk of sulphuric acid, and the resulting indications are in many cases both specific and permanent. Oil of vitriol, which so readily destroys nearly all organic structures, does not carbonise any of the coal-tar colours, or does so only under severe conditions, as at high degrees of heat. Even indigo and madder, although of true vegetable origin, are known to yield up their colouring-matters to sulphuric acid, the old processes of dyeing depending upon this fact. In the manufacture of garancine from madder the woody fibre and organised tissues are destroyed by the action of sulphuric acid, whilst the alizarin glucoside survives, and with it Turkey-red goods may be dyed.† Instances might be multiplied as proof that colouring-matters, both natural and artificial, resist the attack of oil of vitriol, and the large class of sulphonates (Nicholson blues, "acid roseine," &c.) may be cited as establishing the fact that colouring-matters are not so destroyed, but form combinations with sulphuric acid.

If, then, the body under examination be dissolved in strong oil of vitriol, a colour-test is at hand whereby useful inferences may be derived as to the nature of the dye, and often its exact identity disclosed. A few direct confirmatory tests may then be applied. The most remarkable colour reactions are the following:—

Magdala (naphthaline pink)	Blue-black.
Saffranin	Grass-green, becoming indigo-blue on strongly heating.
Crysöidin	Deep orange, turning almost to scarlet on heating.
Alizarin	Ruby-red or maroon.
Eosin	Golden yellow.
Primrose (naphthaline yellow) ..	Difficultly soluble, first yellow, and colour discharged on heating.
Crysaniline	Yellow or brown solution, of marked fluorescent character.
Aurin	Yellowish brown, non-fluorescent.
Atlas orange	Rose colour, turning to scarlet on heating.
Atlas scarlet	Scarlet solution, very permanent on heating.
Biebrich scarlet, R.	Blue-black or deep purple.
,, ,, B.	Bluish green.
Aniline scarlet ..	Golden yellow, permanent on heating.
Indulin	Slatey blue to indigo, according to shade of the dye.
Rosaniline, regina, and all violets ..	Yellow or brownish yellow.
Phenyl and diphenylamine blues ..	Dark brown solutions.
Iodine green } Malachite green } ..	Bright yellow solutions, the former giving off iodine on heating.
Citronine	Pale cinnamon or neutral tint.

After vitriol the action of concentrated hydrochloric acid may be next tried, which distinguishes at once between saffranin and Biebrich scarlet, the former giving a violet solution and the latter being precipitated as a red flocculent powder.

Proceeding in this way, and combining the observation with the dyer's usual test, every one of the substances named can be readily identified, and much time saved in the examination of dye-stuffs.

July 28, 1880.

* Read before the Chemical Section of the British Association, Swansea Meeting, 1880.

† See W. H. Perkin's "History of Alizarin," *Journ. Society of Arts*, May, 1879.

ON A

NEW PROCESS FOR THE PRODUCTION, FROM ALUMINOUS MINERALS CONTAINING IRON, OF ALUMINIUM SULPHATE FREE FROM IRON.*

By J. W. KYNASTON, F.C.S., F.I.C.

It is my privilege to-day to bring to the notice of the Association a new process in manufacturing chemistry, destined probably in the future to occupy an important position in that branch of technical industry to which it relates.

It will be within the knowledge of the members of this section that the consumption of salts of alumina in the arts, especially of paper making, of dyeing, and of calico printing, is already enormous in its dimensions. It will be evident also, on consideration of the purposes for which alumina is required in these arts and manufactures, that

* Read before the Chemical Section of the British Association Swansea Meeting, 1880.

the salt used must be possessed of a considerable degree of purity, and that for some purposes almost absolute freedom from foreign matters is a necessity.

The various aluminous minerals available for the production of salts of this earth are, perhaps, with the single exception of cryolite, invariably contaminated with a greater or less proportion of iron. Even the whitest kaolin or china-clay is never wholly free from this contamination; and inasmuch as the behaviour of oxide of iron towards any of the strong acids is exactly similar to that of alumina, it is not possible to obtain a solution of the latter free from the objectional impurity. And it is owing to this difficulty that, to meet the demand for a pure compound of alumina, manufacturers have been compelled to produce the readily crystallisable double salts of alumina and potassa, or alumina and ammonia, the ordinary potassa and ammonia alums of commerce; these salts in the act of crystallisation rejecting the impurities so difficult to get rid of by any other means.

In the production of these double salts there is required, in the case of the potassa salt, for every part of alumina contained in the salt, very nearly an equal part by weight of potassa, and, in the case of the ammonia salt, a little more than one-half part by weight of ammonia (NH_4O), and in both cases one-fourth part more sulphuric acid than is required to maintain the alumina in solution. These large quantities of valuable materials are, of course, absolutely and irrecoverably wasted, their presence in the alumina salts serving no purpose whatever in the uses to which the salt is applied, and the wealth of the country is diminished by the value these materials would possess if applied to purposes for which they are essential.

This anomaly long ago attracted the attention of manufacturing chemists, and amongst investigators the name of Mr. H. D. Pochin stands pre-eminent as a successful producer of an aluminous compound so free from deleterious impurities as to be available for all the commoner purposes for which soluble alumina is required, and in the manufacture of which there is no waste of the valuable commodities essential to the production of the crystallised salts. The aluminous cake first manufactured by Mr. Pochin, and, since the expiry of his patent, by several others both in this country and on the Continent, is produced in the simplest possible manner, by the action of sulphuric acid upon well calcined china-clay. The materials are carefully intermingled by agitation, and, after being in contact for some little time, the mixture becomes hot, a violent reaction sets in, accompanied by a considerable swelling of the mass, and the evolution of vast quantities of steam. When the action ceases, the swollen mass subsides, and on cooling a hard and tough cake is obtained, which, when crushed or broken up into coarse fragments, is ready for use.

By a careful selection of the china-clay used, and by scrupulous attention to cleanliness in the manufacture, especial care being taken to prevent ferruginous contamination, Mr. Pochin's process yields a crude sulphate of alumina of fairly constant composition. It consists of from 11 to 12 per cent of soluble alumina (Al_2O_3), equal to 37 to 40 per cent of sulphate of alumina, about 20 per cent of silica and undecomposed clay, some 3 or 4 per cent of free sulphuric acid, about 38 per cent of water, and not exceeding one-half per cent of iron, but in some of the purest specimens I have found the iron present below 0·20 per cent. This is, however, unusual.

The deleterious matters present, it will be observed, are iron and free sulphuric acid; the former, when the cake is used in the manufacture of paper, giving to the paper a brownish tint or producing brown spots, and the latter gradually dissolving the wires of the gauze upon which the paper pulp is caught or deposited. But notwithstanding these defects, aluminous cake produced in this way is universally employed in the production of all but the higher qualities of paper, and it will not be easy to displace it.

We now advance a step further in the progress of this manufacture, and a new aluminous mineral is before us, one which, though only recently discovered, already occupies an important position. This mineral is bauxite, so called from the district in which it was first found, namely, at Les Baux in France. Very extensive deposits have since been found in the County Antrim in Ireland, and are worked on a large scale by the Irish Hill Mining Company. The ore is essentially a hydrate of alumina, but contains also that *bête noire* to the manufacturer, peroxide of iron in varying quantity. The French variety has not yet gained a footing in this country; the Irish mineral is already largely employed. An analysis by Mr. John Pattinson, of Newcastle-upon-Tyne, assigns to it the following composition:—

	"First Quality."	"Second Quality."
Alumina	49·80 per cent	51·53 per cent
Peroxide of Iron ..	1·45 ,,	4·53 ,,
Lime	0·57 ,,	0·78 ,,
Magnesia	0·12 ,,	0·20 ,,
Potash	0·01 ,,	0·02 ,,
Soda	none ,,	0·06 ,,
Silica	8·02 ,,	11·89 ,,
Titanic Acid	5·37 ,,	6·14 ,,
Sulphuric Acid	0·06 ,,	0·07 ,,
Phosphoric Acid ..	trace ,,	trace ,,
Combined Water ..	27·07 ,,	23·79 ,,
Moisture	7·50 ,,	0·90 ,,
	99·97	99·91

A noticeable feature in the character of this ore is the large quantity of titanic acid which it contains. In the French mineral it is not present.

Immediately upon the discovery of this mineral, and the determination of its composition, it was seen to be a valuable material for the production of aluminous salts, and many active and intelligent minds have since been engaged in its study. The percentage of Al_2O_3 it contains is greater than that of any other available aluminous mineral; it is more readily acted upon by sulphuric acid than china-clay, even without the necessity of submitting it to previous calcination, and it can be purchased at far less cost than the finer qualities of china-clay, whilst its proportional yield of soluble alumina is far greater.

The great impediment to its instant adoption was that it contained a much higher percentage of iron. The bulk indeed is rarely found with less than from 2½ to 3 per cent of iron in the form of Fe_2O_3, and, as from one ton there is produced about three tons of the dry sulphate, the latter contains from 0·75 to 1·00 per cent of iron, a proportion that renders the salt valueless for any but the most common purposes.

Mr. Peter Spence, the extensive alum manufacturer of Manchester, produces also this crude sulphate of alumina, and has given it the name, in recognition of its impure character, of alumino-ferric cake, and, impure as it is, it is said to be largely used in the manufacture of the lower qualities of paper.

From amongst the many attempts which have been made to produce a pure sulphate of alumina from bauxite a few may be mentioned. Premising that there is a great similarity of behaviour between peroxide of iron and alumina, the task is one of no common difficulty, whether the object be to remove iron from the mineral before attacking the latter with sulphuric acid, or to eliminate the iron from solution after being dissolved with the alumina.

Mr. H. B. Condy has endeavoured to effect the removal of iron from bauxite by reducing it from the very difficultly soluble state in which it exists in the ore to a condition in which it becomes more soluble in mineral acids; that is, by reducing it from the ferric to the ferrous state. In his process, the bauxite is mixed with a solution of sulphide of sodium, and the mixture is heated and well agitated for the space of two hours. The bauxite is then allowed to subside, the supernatant liquid is drawn off, the residue

once or twice washed with water, and then digested with warm hydrochloric acid. The iron dissolved is then removed by washing and filtration. It is certain that some iron is removed from bauxite by this treatment; but even if the treatment be repeated again and again, the purification is still very incomplete, whilst the process itself is costly and tedious beyond endurance.

By another process Mr. Condy subjects bauxite to the action of sulphide of sodium by heating the materials together in a close furnace. There is then formed a compound consisting of sulphur, sodium, and alumina, soluble in water, and of insoluble sulphide of iron. On treatment with water the sulphide of iron deposits and the solution of sulpho-aluminate of soda is decomposed by acetic or carbonic acid, and aluminia precipitated in the pure state. This, dissolved in sulphuric acid, yields a pure sulphate of alumina. The process is ingenious, but the manipulation exceedingly difficult and expensive, and it will not be possible to produce in this way sulphate of alumina to replace the ordinary crystallised alums.

Dr. Loewig, of Silesia, has published a process for obtaining hydrate of alumina from a mixture of bauxite and cryolite, producing at the same time caustic soda. As this process requires the use of lime as a precipitant of the alumina, and as lime free from iron cannot be obtained, sulphate of alumina free from iron cannot be produced from this product.

Messrs. Duncan and Newlands have devoted much attention to this matter. They propose "to treat bauxite with hydrochloric acid, either strong or dilute, for several hours, preferably at a temperature approaching the boiling point, when a large proportion of the oxide of iron is dissolved along with a certain amount of alumina. The solution thus obtained is ran off, and the residual mass is washed with water." They also propose to purify bauxite by submitting a mixture of the ore "with a quantity of finely ground coal, coke, charcoal, or other carbonaceous matters, to a bright red heat, allowing as little access of air as possible, when the oxides of iron are reduced to a lower state of oxidation or even to the metallic state," or they "reduce the oxides of iron by heating the bauxite to bright redness, and then passing through the mass a current of hydrogen, carbonic oxide, coal gas, or other reducing gases."

In either case, the mass after cooling is further treated with more or less strong hydrochloric acid, which effects the solution of a portion of the iron. The bauxite treated by either of these methods is used for the production of sulphate of alumina by digesting with sulphuric acid in the ordinary way, and undoubtedly yields a purer salt than it is possible to obtain from bauxite not so treated. There is, however, still iron present in as great a proportion as is contained in the ordinary aluminous cakes prepared from the purer qualities of china-clay by a more economical method.

In the course of the investigation of this matter which I have undertaken, I have found that oxalic acid has the remarkable power of dissolving the oxides of iron contained in bauxite to a far greater extent than even strong hydrochloric or nitric acid, and this without any preliminary treatment of the ore, except the necessity of reducing it to a fine state of division. This process of purification can also be worked without material loss of the oxalic acid employed. In practice I have carried out the process as follows:—

I take finely powdered bauxite and mix it to a thick cream with a solution of oxalic acid, containing from 5 to 10 per cent of the weight of the bauxite, and about the same proportion of hydrochloric acid, the latter being used to prevent the formation of insoluble oxalation should lime be present in the bauxite. The mixture is allowed to stand at rest or with occasional stirring for a week or ten days. There is then added five or six times as much water as the bulk of the mixture. The whole is thoroughly agitated, and then allowed to stand till the bauxite is deposited. The latter is again repeatedly washed until free from oxalic acid and dried, and by treatment in the ordinary way with sulphuric acid, sulphate of alumina is obtained, containing not more than 0·10 to 0·20 per cent of iron, and about 16 per cent of alumina, a purer product than has ever before been obtained by the direct action of sulphuric acid on aluminous minerals.

The strongly acid solution of oxalate of iron (containing also some alumina) obtained in this process of purification is mixed with milk of lime, considerably more than equivalent to the oxalic acid present, but still leaving the mixture strongly acid. After standing two or three days, the oxalic acid is thus almost perfectly precipitated as oxalate of lime. This precipitate is well washed, and then boiled with its equivalent of sulphuric acid. The sulphate of lime produced is allowed to settle out, and a clear solution of oxalic acid is again obtained, available for the purification of a second portion of bauxite, as before described.

Notwithstanding the unexpectedly satisfactory result obtained by this process of manufacture, it, like those before washing is enhanced by reason of the comparative lightness mentioned, has its disadvantages. The apparatus required is of large extent for a small production. The difficulty of of the mineral; it settles from water with difficulty, and after having settled as perfectly as possible, the wet clayey mud contains an enormous proportion of water, which must be evaporated before the mineral can be used for the production of sulphate of alumina. For the same reasons it is difficult to remove the last portions of the impurities dissolved by the acid employed, and, even the purest sulphate of alumina that can be produced by such means of purification would probably have a commercial value not greatly in excess of the ordinary aluminous cakes produced more simply and economically from china-clay; and the object in view, viz., the economical production of a sulphate of alumina sufficiently pure to displace the crystallised alums, is still unattained.

These considerations led me to continue the investigation of the matter, and at the same time forced upon me the conclusion that the only satisfactory mode of purification would be one which either prevented the solution of the iron oxides when bauxite is treated with sulphuric acid, or one which effected the separation from the alumina solution of the dissolved iron by some process of precipitation.

(To be continued.)

NOTES OF WORK BY STUDENTS OF PRACTICAL CHEMISTRY

IN THE

LABORATORY OF THE UNIVERSITY OF VIRGINIA.

No. IX.

Communicated by J. W. MALLET,
Professor of General and Applied Chemistry in the University.

(Concluded from page 181.)

(55.) *On the Incandescence Exhibited by Cupric Antimonate on being Strongly Heated.* By C. L. ALLEN, of Charleston, S. Carolina.

Berzelius has recorded* the observation that certain antimonates and antimonites when exposed to a slight red-heat, after water of crystallisation has been expelled, present a transient but bright incandescence, looking like combustion, without any change of weight being experienced. The glowing is said to be especially noticeable with the antimonates of copper, cobalt, and zinc. In another passage† the same author says that zinc antimonate does *not* incandesce. As this phenomenon does not

* Berzelius, "Traité de Chimie" (Paris, 1830), ii., 499.
† *Ibid.*, iv., 269.

appear to have been observed by anyone else, it seemed worth while to try to reproduce it, determining the conditions of its occurrence.

Neutral potassium antimonate (of Fremy, better called met-antimonate) was prepared by fusing purified metallic antimony with four times its weight of nitre, washing the mass with cold water, and dissolving the residue by prolonged boiling with water. In a portion of the solution the amount of antimony actually present was determined, and after dilution an equivalent quantity of cupric sulphate was added. The light green precipitate obtained was washed and dried, finally at 100° C. The product so obtained consisted of $Cu(SbO_3)_2.4H_2O$.* Heated to about 260° C. for some time, 12·01 per cent of water was given off, and collected in a chloride of calcium tube, this corresponding to about 3 molecules of water (calc. = 11·46 p.c.). At about 360° nearly the whole of the remaining water was given off, there being a further loss of 3·36 per cent (calc. = 3·83 per cent). It required a low red-heat to drive off the last traces of water, the total loss being now equal to 15·68 per cent (calc. for $4H_2O$ = 15·29 per cent). Only by strong ignition over a blast (gas) lamp was the phenomenon of incandescence produced, but when it occurred it was quite bright and distinct. No further alteration of weight occurred, and as the temperature was much above that at which the last of the water was removed, while there is no reason to suspect any change of chemical relation between the remaining constituents, the phenomenon seems most probably one dependent upon change of physical structure only, as O. Popp† has made it likely that the analogous glowing of magnesium pyrophosphate in the ignition of ammonium-magnesium phosphate is to be considered.

Berzelius states that cupric antimonate becomes black when heated but sufficiently to drive off the water, and after ignition and glowing appears white with a slightly greenish tinge. This statement (as well as the proportion of water said to be lost) renders it probable that the salt he experimented with contained an admixture of cupric hydrate, as Mr. Allen found to be the case with a specimen he prepared by means of crude potassium antimonate insufficiently washed with cold water and retaining potassium hydrate. In such case cupric oxide is first left on moderate heating, and appears when more strongly ignited to enter into union with the antimonate, forming a basic salt. With pure cupric antimonate Mr. Allen found the original pale bluish green colour to change on heating to a more and more yellowish green, becoming finally, after incandescence and cooling, a pale greenish grey, but there was at no time any blackening.

(56.) *Analysis of Amphibole (var. Actinolite) from Amelia Co., Va.* By F. A. Massie, of the University of Virginia.

Accompanying some specimens of asbestos exhibited at the Annual Fair of the State Agricultural Society, in October, 1879, by Mr. W. R. Faulkner, of Chula, Amelia Co., Va., were several large lumps made up of light green crystals, easily crumbled apart between the fingers. The individual crystals were quite small, generally about 1 to 2 m.m. long, and ½ to 1 m.m. through laterally. They were slightly stained in some places by ferric hydrate, easily removed by hydrochloric acid. The angle I ⌒ I = 124° 30′ was repeatedly obtained with the microscope goniometer, as also the same angle between cleavage planes. Hardness = nearly 6; sp. gr., 3·041; lustre, vitreous; colour, light grass-green; streak, almost white; As transparent as common green window-glass; fusible with difficulty before the blowpipe flame.

Analysis of picked crystalline grains, air-dried, after washing with hydrochloric acid, gave—

Silica	56·96
Alumina	4·32
Ferric oxide	2·45
Ferrous oxide	2·24
Magnesia	22·33
Lime	11·44
Water	0·31
	100·05

corresponding to the formula $(\frac{11}{14}R'' + \frac{3}{14}R''')SiO_3$, that of a meta-silicate, mainly of magnesium and calcium, with a certain amount of isomorphous replacement by dyad and triad iron and by aluminium.

(57.) *Analysis of a Highly Aluminous Pyroxene from Amhurst Co., Va.* By W. T. Page, of Norfolk, Virginia.

In immediate association with magnetic iron and the allanite found in remarkable quantity in the gneissoid rocks of Amhurst Co., in this state, masses, sometimes of a foot or more through, are found of a black pyroxene, of which specimens have several times been sent to me by the people of the neighbourhood as allanite or as iron ore. The mineral occurs in confusedly crystalline masses, with an approach to foliated structure in some parts, and in which the I cleavage can be here and there imperfectly identified. Hardness = fully 6; sp. gr. = 3·420; lustre between vitreous and sub-metallic, in places verging upon pearly; colour, black; streak, ash-grey; translucent only on the edges of their splinters; difficultly fusible before the blowpipe.

The following results were obtained on analysis by Mr. Page, the absence of ferrous iron having been ascertained:—

Silica	42·50
Alumina	15·39
Ferric oxide	11·32
Magnesia	7·50
Lime	22·67
	99·38

These figures lead very closely to the regular meta-silicate formula, counting in most of the aluminium with silicon, the extent of basic and acid replacement being represented pretty nearly by—

$$(\tfrac{9}{10}R'' + \tfrac{1}{10}R''')\,(\tfrac{19}{20}Si + \tfrac{1}{20}Al)O_3.$$

The amount of aluminium present is unusually large.

(58.) *Analysis of a Ferruginous Mineral, probably referable to Amphibole, from Amhurst Co., Va.* By A. L. Baker, of Baltimore, Maryland.

This mineral also accompanies allanite (though not in the same specimens with the preceding), and is often attached to it so closely that the line of partition of the two may be easily overlooked upon the surface. It occurs in masses of fibrous structure, like compact asbestos. Occasionally it tends to become lamellar. Hardness = 6; sp. gr. = 3·32; lustre, sub-metallic to silky; colour, black; streak, reddish grey; moderately fusible, about 3·5, before the blowpipe.

A careful examination proved that the iron was exclusively in the ferric condition. Analysis gave—

Silica	37·18
Alumina	6·29
Ferric oxide	39·01
Magnesia	3·80
Lime	14·10
	100·38

The general habit of the mineral suggests a hornblendic character, and from the above analysis may be calculated the formula—

$$(\tfrac{3}{4}R'' + \tfrac{1}{4}Fe''')\,(\tfrac{3}{4}Si + \tfrac{1}{8}Al + \tfrac{1}{8}Fe''')O_3.$$

* Berzelius (iv., 355) says that cupric antimonate gives off on heating 19½ per cent of water, which would correspond to nearly 5½ molecules.

† *Zeitschr. f. Chem.*, 1870, 305.

But this requires the presence of basic triad iron to a very unusual extent, and the occurrence of a little of the same metal even as replacing with aluminium the silicon. Although the mineral appeared under the microscope to be homogeneous, the red-brown tinge of the streak suggests the possibility that some of the iron may have existed as ferric oxide in a state of very intimate admixture.

(59.) *On the Solubility of Carbon Disulphide in Water.* By W. T. Page, of Norfolk, Va.

In most of the standard text-books of chemistry it is stated that carbon disulphide is "insoluble in water," "not sensibly soluble," or "nearly insoluble." It must have been often noticed that water shaken up with the sulphide acquires its odour, and hence some degree of solubility might have been inferred. The only attempt on record, so far as I know, to determine accurately to what extent solution really takes place, is that of Sestini,* who found in a single experiment that 30 c.c. of CS_2 shaken up with 8·69 litres of water at 20° to 23° C. diminished by 11 c.c. in nine days, by 1·4 c.c. in the next three days (in diffuse light), and by 0·6 c.c. in five days more (in the absence of light). He states that a part of the sulphide was decomposed, and that the coefficient of decomposition was in the light 0·35, in darkness 0·12, without giving any information as to how these determinations were made, and hence concludes that in this experiment 7·85 c.c. of CS_2 had been dissolved, or about 1 part in 1000 of water by weight: this should be, more accurately stated, 1 in 873.

Mr. Page employed pure water, deprived of air by long-continued boiling, and cooled down in a well-closed flask filled nearly up to the stopper from another like flask just before removal from the lamp. The stopper being removed for a few moments, recently-purified carbon disulphide was introduced to the extent of two or three cubic centimetres (more than the water present could dissolve), the air was expelled from the very small remaining space by carbon disulphide vapour, the well-fitted stopper was inserted, and as a further precaution against any entrance of air the stopper and upper part of the neck of the flask were surrounded by water or mercury. Each such vessel was shaken at short intervals from day to day. Some of the vessels were kept exposed to diffuse light; others were kept in the dark in a cellar. With the precautions mentioned no evidence of decomposition of the sulphide was obtained. It was found that the solution could be oxidised with tolerable rapidity at common temperature by quickly and accurately measuring off known volumes, adding to each an excess of potassium permanganate acidified with nitric acid, and keeping the whole in a well-stoppered bottle until the change was complete. The sulphuric acid formed was determined as barium sulphate. Calculating from the quantities of sulphur thus found, the following results were obtained:—

Time of Contact with Water.	Average Temperature (nearly constant).	Solubility of CS_2.
30 days	12° to 13° C.	0·203 in 100 by weight
Do.	Do.	0·198 ,, ,,
55 days	15° to 16°	0·191 ,, ,,
7 days	25° to 27°	0·168 ,, ,,
27 days	30° to 33°	0·146 ,, ,,
Do.	Do.	0·143 ,, ,,

It will be seen that the solubility diminishes with rise of temperature; but, so far as shown by these few determinations, this diminution does not occur at a rate equal to that at which the vapour-tension of CS_2 increases, as shown by the tables of Renault and Marx.

(60.) *Examination of Livingstonite from a New Mexican Locality.* By W. T. Page, of Norfolk, Va.

About a year ago my friend, Senor Mariano Bárcena, of the City of Mexico, described, at a meeting of the Sociedad Mexicana de Historia Natural, some specimens of a mineral from Guadalcázar, in S. Luis Potosi, resembling in most respects the Livingstonite which he had previously described from Huitzuco, in Guerrero, and whose complete analysis, made in this laboratory, was published last year.*

There being some difference in the general aspect of the specimens from these different localities, Senor Bárcena thought it possible that either a special variety or a species containing its constituent sulphides of antimony and mercury in new proportion might be represented by the Guadalcázar specimens, which he had but qualitatively examined. He sent some of the latter to me, therefore, for full chemical analysis.

The main point of difference between the mineral from the original locality, Huitzuco, and that now examined is that the former occurs in small, but pretty well defined, prisms, either single or grouped together with general parallelism of direction, while the Guadalcázar mineral is in small globular masses made up of delicate capillary or needle-like crystals interlaced with each other in all directions. The colour of the latter is lead-grey, with metallic lustre; streak, cochineal-red; hardness = 2; brittle; sp. gr. = 4·41 (that of the Huitzuco mineral = 4·81, but this was less mixed with earthy gangue). Very easily fusible before the blowpipe flame, giving off copious white antimonial fumes. Yields globules of mercury when heated in a glass tube with soda. Attacked by strong, heated nitric acid, leaving a white insoluble residue. Occurs, as is the case at Huitzuco, in a gangue of gypsum, along with native sulphur. but there is also some siliceous matter present. These foreign substances were mechanically removed as far as possible beforehand, and further amounts, intimately mixed with the Livingstonite, had to be separated in the course of the analysis, the free sulphur by solution in carbon disulphide. The total quantity of sulphur obtained from the solution in *aqua regia* was checked by a fusion with nitre and sodium carbonate. The mercury was checked by distillation with lime.

Mr. Page obtained—

Sulphur (combined)	15·12
Sulphur (free)	3·67
Antimony	32·22
Mercury	13·95
Iron	0·42
Gypsum ($CaSO_4.2H_2O$)	15·54
Insoluble siliceous residue	18·01
	98·93

Throwing out the iron and other non-essential substances, these figures give the atomic ratio—

$$S : Sb : Hg = 7·04 : 4·0 : 1·04,$$

obviously corresponding to the formula already established for Livingstonite—

$$HgS.2Sb_2S_3,$$

so that there seems no reason to doubt that the mineral from Guadalcázar is correctly referred to this species—an interesting one, as was noticed in a former paper, on account of the highly acid character of the sulph-antimonite it represents.

(61.) *Examination of an Altered Livingstonite from Guadalcázar, S. Luis Potosi, Mexico.* By W. T. Page, of Norfolk, Va.

Another specimen, from the same locality as the preceding, but of manifestly different appearance, was separately examined. It formed a nearly compact mass, with traces only of crystalline structure, of iron-grey, almost black, colour, very dark grey streak, and dull sub-metallic lustre. Hardness = 3; sp. gr. = 4·06; blowpipe characters nearly as for Livingstonite; imperfectly attacked by nitric or

* *Gazz. Chim. Ital.*, 1871, 473. *Ber. der Deutsch. Chem. Gesell.*, 1872, 288.

* Chemical News, vol. xl., p. 186. *Revista Scientifica Mexicana*, February 1, 1880, 7.

hydrochloric acid; contained, besides the same intermixed gangue materials as those of the preceding specimens, a little of a hard clay-like substance.

The general course of analysis was the same as in the preceding case; but a large apparent loss having led to the discovery that oxide of antimony was present, the oxygen of this was determined by very careful reduction in a slow stream of hydrogen, directly weighing the water produced. The mineral had been dried at 100° C., and lost no constituent water by mere heating above this temperature. Analysis gave—

Sulphur (combined)	9·35
Sulphur (free)	10·11
Antimony	38·23
Mercury	18·24
Oxygen	4·99
Gypsum ($CaSO_4.2H_2O$)	5·12
Iron	0·01
Alumina	1·57
Insoluble siliceous residue	11·01
	98·63

Neglecting non-essential ingredients as before, we have the atomic ratio, as against that of Livingstonite,—

S : O : Sb : Hg = 12·84 : 13·71 : 14·0 : 4·01
S : Sb : Hg = 28·00 : 16·0 : 4
(In Livingstonite.)

No probable formula can be obtained. The substance in question seems to represent the result of chemical alteration of Livingstonite by the replacement of more than half the sulphur by oxygen, forming probably Sb_2O_3, and the removal of a further portion of the sulphur and a part of the antimony altogether. The streak being nearly black, with no reddish tinge, suggests that the mercuric sulphide has either been left free in the physical condition in which it exists in the meta-cinnabarite of California, or remains as part of a *basic* sulph-antimonite, approximating in composition to $2HgS.Sb_2S_3$. Oxidation of the same original species, accompanied by hydration, has in all probability led to the formation of the mineral Bárcenite formerly described* by me.

(62.) *On the Artificial Production of Livingstonite.* By A. L. Baker, of Baltimore.

The composition of Livingstonite being remarkable for the large proportion of the acid antimonious sulphide which it contains, it seemed interesting to attempt to produce it artificially, and experiments looking to this result were made by Mr. Baker. Trying various modes of fusing together the sulphides of antimony and mercury, he at first found much difficulty from the latter of these volatilising pretty rapidly at the temperature necessary for fusion. The natural Livingstonite is itself easily decomposed by heating in a glass tube closed at one end, a sublimate of mercuric sulphide being produced.

By two methods, however, a successful result was reached. The former of these (A) consisted in fusing together the two sulphides, that of mercury somewhat in excess, in a stout glass tube filled with carbon dioxide and sealed, keeping the tube in a vertical position while maintaining for some time the temperature of fusion, and after cooling removing the upper part of the fused mass, leaving at the bottom an impure portion in which the surplus mercuric sulphide had settled in consequence of its greater density. The second method (B) consisted in fusing the mixed sulphides in considerable quantity in an open Beaufaye crucible, in the upper part of which an atmosphere of carbon dioxide was maintained, lowering the temperature gradually, and dropping in now and then a compact lump of (artificially sublimed) cinnabar until the mass was on the point of solidifying. The upper portion of the cooled mass was alone taken for examination, leaving the excess of mercuric sulphide in the bottom portion.

The product from each of these processes agreed essentially with the natural mineral in physical characters. The structure was highly crystalline, much like that of the cakes of common trisulphide of antimony purified by fusion, and the colour was nearly the same, but the streak was dark cherry-red. Specific gravity = 4·928 at 32° C.

Analysis gave—

	(A.)	(B.)	Calc. for $HgS.2Sb_2S_3$.
Sulphur	24·56	24·83	24·78
Antimony ..	—	53·20	53·10
Mercury	22·40	22·71	22·12
		100·74	100·00

(63.) *On the Amount of Water of Crystallisation of Hydrated Strontium Nitrate.* By A. L. Baker, of Baltimore.

There is still some discrepancy of statement in chemical text-books as to the extent of hydration in this salt, most recent writers giving 4 molecules of water, as found by Souchay and Lessen, and by Ordway, while some give 5 molecules, as formerly found by Laurent and earlier experimenters.

In order to ascertain whether by varying the circumstances of crystallisation more than one hydrated salt can be formed, Mr. Baker made a large number of experiments, with different rates of cooling, and of evaporation at uniform temperature, and at temperatures ranging from 2° to 32° C. In no instance was any other result obtained, when individual crystals were picked out for examination, than the anhydrous salt or that with 4 molecules of water. In a few cases a little excess over the exact 4 molecules was found, the result undoubtedly of minute amounts of mother-liquor remaining enclosed in cavities of the crystals. A number of measurements of angles were made, agreeing with those already on record.

As regards the limit of temperature at which the hydrated nitrate is obtainable, Ordway* states that when crystallisation takes place at temperatures above 24° C. the anhydrous salt is usually obtained. By slow evaporation at 32° C. of a saturated solution Mr. Baker obtained in one instance a mixture of anhydrous and hydrated crystals.

University of Virginia,
September 7, 1880.

* *Amer. Jour. Sci.*, October, 1878, 306. *Boletina del Sociedad Mexicana de Historia Natural*, October 12, 1878.

* *Amer. Jour. Sci.*, [2], 27, 18.

CORRESPONDENCE.

ON THE SPECIFIC ROTATORY POWER OF CANE- AND INVERT-SUGAR.

To the Editor of the Chemical News.

Sir,—In a paper with the above title, which appeared in the Chemical News, vol. xlii., p. 177, Mr. Allen announces the discovery of what he considers an error in the calculation of the specific rotatory power of inverted sugar. He says:—

"In calculating the specific rotatory power of invert-sugar, Watts and many other authorities have apparently fallen into an error. They appear to have assumed that a solution of inverted sugar, after correction for change of bulk, contained the same percentage of solid as before inversion. This, of course, is contrary to fact, 95 parts of cane-sugar yielding 100 of invert-sugar. Hence this increase in weight must be taken into consideration in calculating the specific rotatory power of inverted sugar."

Now, Sir, it appears to me highly improbable that anyone who had occasion to make such a calculation should

omit this very obvious correction. Moreover, an error of the kind indicated above, instead of giving $-25°$, gives a number even *higher* than that given by Mr. Allen as the corrected one. Mr. Allen gets the value $-25{\cdot}6$ at 15° C. for $[a]j$ from the formula—

$$[a]j = \frac{-36{\cdot}5 \times 0{\cdot}24}{2 \times \frac{16{\cdot}26}{95}} = -25{\cdot}6°.$$

Omitting the correction the formula gives—

$$[a]j = \frac{-36{\cdot}5 \times 0{\cdot}24}{2 \times \frac{16{\cdot}26}{100}} = -26{\cdot}93°.$$

$-26{\cdot}93°$ instead of $-25°$ as Mr. Allen supposes.

It will thus be seen that no such gross error has been made in the calculation. Neither is a mistake of this kind possible in the case before us, as the value $-25°$ given in "Watts's Dictionary" and elsewhere is the *calculated* specific rotatory power of invert-sugar, and not the *observed*. As shown by Kekulé (*Lehr. d. Organ. Chem.*, Bd. II., 349), it is the mean of the *observed* rotatory powers of dextrose $+56°$ (Berthélot) and levulose $-106°$ (Dubrunfaut), calculated on the assumption that invert-sugar consists of equal parts of dextrose and levulose; thus:—

$$\frac{-106}{2} + \frac{+56}{2} = -25°.$$

This method of calculation Mr. Allen evidently does not consider erroneous, as he has used it in order to obtain the value for levulose which he gives in his paper.—I am, &c.,

Alexander Watt.

Liverpool, October 12, 1880.

DIAZO COLOURS.

To the Editor of the Chemical News.

Sir,—I should like to call your attention to an article in the Chemical News, vol. xlii., p. 60, on "Diazo Colours," and signed by Mr. Meldola, who claims that the colours I described in a paper before the American Chemical Society (wherein I mentioned a compound produced by combining three sulpho groups in the same molecule) are not new, as he had previously taken out a patent covering all such colours as above mentioned. This fact I was unaware of at the time I read my paper, otherwise it would not have been mentioned. I beg that you will insert this in the columns of the Chemical News.—I am, &c.,

James H. Stebbins, jun.

New York, September 26, 1880.

OBITUARY.

We regret to record the death of Mr. Thomas Charles Boake, Analytical Chemist, of 46, Boleyn Road, Stoke Newington, who was accidentally killed at Victoria Park Station, on the 7th instant. The deceased, who was twenty-one years of age, was the nephew of Mr. Arthur Boake, the senior partner of the firm of A. Boake and Co., of Stratford. Mr. Boake was a young chemist of great promise, he was a genial warm-heated Irishman, and is deeply regretted by all who knew him.

Inconveniences, from a Physiological Point of View, of the Substitution of Amylic Alcohol for Ether in Stas's Process for the Detection of Morphine.—MM. G. Bergeron and L. L'Hote.—As amylic alcohol, even in very small doses, produces in animals symptoms closely resembling narcotism, and as it is not readily removed from the cadaveric extract, physiological experimentation in confirmation of the chemical reactions of morphine is rendered untrustworthy.—*Comptes Rendus.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 7, August 16, 1880.

Observation made on a Group of Rays in the Solar Spectrum.—L. Thollon.—The author figures and describes a group of four rays, situate in the orange. Two of these rays belong to iron, their wave-lengths being respectively 5976·1 and 5974·6. The other two are telluric, and their wave-lengths are 5976·35 and 5974·36.

Cause of the Variations of the Fixed Points of Thermometers.—J. M. Crafts.—The author cites some experiments which reduce to nothing, or almost so, the part played by pressure in the permanent elevation of the zero-point. The glass blown at the lamp and exposed for a long time to the action of heat diminishes in volume by means of some internal change, and it is not demonstrated that pressure plays any part whatever in the phenomenon. The particles of glass which have been removed asunder whilst it was being blown do not return immediately to their normal position at a lower temperature; we observe disturbances for some time, and finally the glass may remain for a long time in a state of tension at the ordinary temperature. The action of heat at a given temperature (*e.g.*, 355), giving a greater mobility to the particles, favours their return to the normal position, and gives scope to a contraction. But the glass, when cooling from this latter temperature retains a part of the displacement peculiar to 355°. On heating again to a lower temperature (*e.g.*, 300) a new decrease of volume is produced, so that a very slow cooling, which produces successively all these effects upon the particles of glass, must ensure the greatest stability.

Rapid Alcoholic Fermentation.—J. Boussingault.—In order to effect rapid fermentation for the destruction of the sugar contained in wines, the sample is mixed with water and yeast, and placed in connection with an exhausting syringe, which reduces the pressure, and thus eliminates the alcohol as fast as formed. The fermentation not being checked by its presence goes on till all the sugar is decomposed.

Spectroscopic Examination of Thulium.—R. Thalén.—I have submitted to spectroscopic examination certain aqueous solutions received from M. Cleve, supposed to contain the new metal thulium, and I have studied the absorption-spectrum, that of emission, and the brilliant spectral rays produced by the induction-spark. For observations on the absorption-spectrum I have employed two concentrated solutions of the nitrate, one of which, of a rose colour, was said to be rich in erbium, whilst the other, almost colourless, was rich in thulium. On comparing the two absorption-spectra I found the majority of the bands identical in both as regards their mean positions, whilst their intensity and their breadth varied much according to the nature of the solution employed. Thus in the spectrum of thulium, where all the other bands are much fainter and narrower than the corresponding bands in the spectrum of erbium, we observe two very broad bands of striking intensity. The blackest band already indicated in the communication which M. Cléve has made on this subject (*Comptes Rendus*, lxxxix., p. 479), is situate between the Frauenhofer rays C and B, and very near B ($\lambda = 6840$) when the solution is dilute. In case of a concentrated solution it extends beyond B, and advances almost up to the ray a ($\lambda = 6800$—7070). This band is characterised by the circumstance that other things being equal it retains its darkness perfectly, even when the dispersion of the spectroscope is much increased. The other band, situate in the blue ($\lambda = 4650$), is very broad

and dark in weak spectroscopes, whilst it is much slenderer if the dispersion becomes at all great. These two bands, especially the former, ought, it seems, to be attributed to thulium. As for the other bands, which all belong to erbium, I shall here dispense with giving the measurements which I have re-determined. As is well known the aspect of absorption-bands changes much, either with the degree of concentration and density of the absorbent liquid, or in consequence of the greater or less dispersion of the spectroscope employed. It may suffice, therefore, to refer to the values already given either by myself (*loc. cit.*) or by MM. Bahr and Bunsen (*Annalen der Chemie und Pharmacie*, bd. 137, p. 1, 1866), whose measurements agree fairly with my own. For the emission-spectrum and that produced by the induction-spark, I have made use of the purest erbium and thulium chlorides which M. Clève has prepared. On igniting in the non-luminous flame of gas a small bead of borax moistened with a solution of the chloride either of erbium or thulium, I have seen the bead shine with a very intense greenish light, the spectrum of which is composed of the luminous bands already observed by Bahr. But on carefully comparing together the spectra given by the two chlorides, I have found in some respects notable differences. In the first place the spectrum of thulium contains two new bands, one of which, very broad and intense, coincides exactly with the black absorption-band in the red part of the spectrum above-mentioned, whilst the other, situate in the blue ($\lambda=4760$), has not a corresponding black band. On the other hand I have seen no trace of the luminous band ($\lambda=4650$), which ought to correspond to the absorption-band already named, although this luminous band appears very intense in the irradiation-spectrum due to erbium. Hence it may be doubted whether the black band ($\lambda=4650$) really belongs to thulium or not. Nevertheless, if we admit, at least, that the red band ($\lambda=6840$) is peculiar to thulium, it appears that this metal, like erbium and didymium, possesses the remarkable property of giving an emission-spectrum. Lastly, in the luminous spectrum produced by the induction-spark, I have found many of the brilliant rays belonging to ytterbium, and at intervals I have seen also some of the rays of erbium, which, nevertheless, shone only for an instant. But, besides, I have observed about 15 rays which ought really to be attributed to thulium. These rays are almost all of a feeble intensity, but they will nevertheless, I think, suffice to characterise the body in question. The following are the wave-lengths of the brilliant rays of thulium which I have observed by means of three flint glass prisms of 60°:—

Wave-length.	Intensity.
5961·5	6
5896·0	2
5675·0	4
5305·7	2
5033·5	3
4733·0	6
4615·0	5
4522·0	4
4481·0	5
4386·5	4
4359·5	4
4241·5	5
4204·0	5
4187·5	5
4106·5	6
4093·0	6

In fine, the various spectroscopic facts just mentioned prove, it seems to me, the existence of the new metal thulium, though it must be admitted that chemists have not yet succeeded in separating it from two other bodies, ytterbium and erbium, with which it is at present mixed.

Absorption-spectra of the Metals forming Part of the Groups of Yttria and of Cerite.—J. L. Soret.—Important progress has lately been made in the knowledge of the metals of the groups of yttria and of cerite, and, thanks to the kindness of M. Marignac, who has permitted me to examine a great number of his products, I have been able to complete my former observations on their properties of spectral absorption. In this paper I shall speak only of the four metals which give rise to an absorption-spectrum, characterised by several rays or bands within the limits of the extent of the solar spectrum. I give an approximate diagram of these spectra for the violet and the ultra-violet portion, which is very characteristic. [The author has used chlorides dissolved in 50 equivs. of water, the thickness of the stratum being 0·01 metre. The position of the principal solar rays is indicated in the diagram.]

1. *Erbium.*—I have little to add to what I have already said concerning this body. An attentive study permits me to conclude that from the list of rays formerly attributed to this element (see Lecoq de Boisbaudran, "Spectres Lumineux) must be erased that of the red $\lambda=683{\cdot}7$, which behaves in a perfectly special manner (thulium), and three rays, $\lambda=640{\cdot}5$, $536{\cdot}3$, and $485{\cdot}5$, which belong to a following metal (holmium, X). On the other hand there must be added two rays, which, to my knowledge, have not yet been pointed out; the one, very faint and difficult to distinguish, is found in the blue, $\lambda=468$; the other, narrow and easily recognised by gas light, is in the indigo, $\lambda=442$. The diagram given of the most refrangible part of the spectrum of erbium refers to a chloride containing a large proportion of other metals, especially ytterbium. Doubtless in pure erbium the rays would be more distinct.

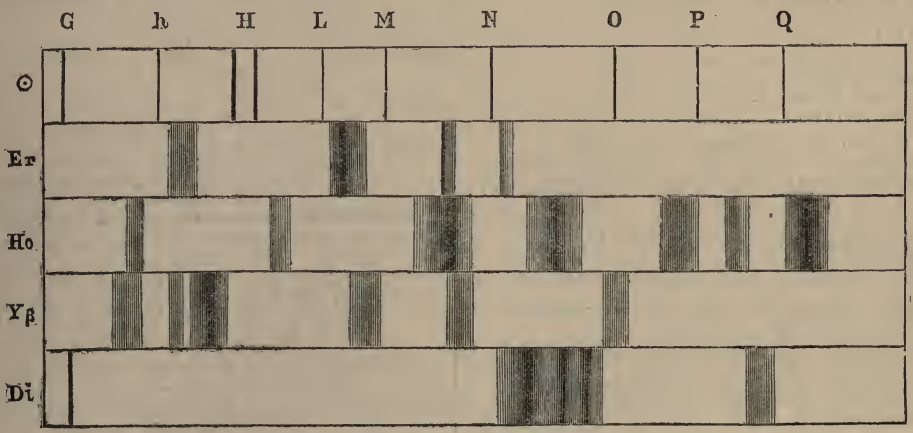
2. *Holmium* (earth X).—I think I have fully demonstrated the existence of a metal, which almost constantly accompanies erbium, and which I have provisionally designated X. M. Delafontaine at first considered it identical with philippium; then, in ulterior and recent researches (*Archives des Sciencez Physiques et Naturelles*, March, 1880), he has recognised that these two bodies are different, and in particular that philippium does not give a spectrum with absorption rays. The examination of the spectrum of erbium has also led M. Clève to detect a new element, for which he proposed the name holmium, but which he afterwards recognised as identical with the metal X (*Comptes Rendus*, Sept. 1, and October 27, 1879). I might urge my right to choose a new name for this element, which can no longer be confounded with philippium, and the existence of which I first established after a spectral examination, but this would be to introduce more confusion in a subject already very complex, and along with M. Marignac I formally adopt the name holmium proposed by the skilful Swedish chemist. The following is the list of rays which characterise holmium:—

Extra red	$\lambda=$ 804 (?)	Very strong.
,,	753	Faint (new).
Red	640·4	Very characteristic.
Yellow-green	536·3	
Green-blue	485·5	Hitherto ascribed to erbium.
Blue (?)	474·5	Very faint, nebulous.
Indigo-blue	453—449	Coincides with a ray of erbium.
Indigo (?)	430	Doubtful.
Violet	414·5	
Ultra-violet, solar	$\lambda=389-387$	See diagram.
	$\nu=368-360$	
	$\omega=347-353$	
	$\pi=340-336$	
	$\chi=$ 332·5	
	$\rho=$ 327	
Extreme ultra-violet	270—240	Broad band.
,, ,,	219·5	Narrow, coincides with 25 Cd.

In the numerous products which I have examined these rays have constantly appeared to behave in the same manner; they become stronger or fainter simultaneously according to the strength of the solution. They form a well-defined group perfectly distinct from that of the rays

of erbium. These facts, confirmed by the observations of M. Clève, of Lecoq de Boisbaudran, and M. Delafontaine place the existence of holmium as an element beyond doubt.

3. *Earth* Yβ (Marignac), *Samarium* (Lecoq de Boisbaudran), *Decipium* (?) (Delafontaine). Samarium is without doubt identical with the metal which M. Marignac designates provisionally as Yβ, to reserve the rights of M. Delafontaine to the discovery of this body, as it is possibly the decipium of the latter chemist (*Archives des Sciences Physiques*, May, 1880). I can only confirm the exactitude of the description which M. Lecoq de Boisbaudran gives of the less refrangible portion of the spectrum as far as the violet. The violet and ultra-violet portion is represented in the diagram. We observe:—(1.) In the violet a band η, which has been also studied by M. Lecoq de Boisdaudran; λ=419—415. It appears to me to have two maxima of intensity. (2.) A narrower band θ', a little more refrangible than *h*; λ=408—406; easily distinguished. (3.) A band θ, of enormous intensity; a little less refrangible than H; very characteristic. It coincides with a much less distinct band, which I have previously pointed out in this place, either in terbium or didymium, extracted from cerite. It seems to me that these latter products contain a small proportion of the new earth, manifested by a trace of the band θ. (4.) The ray μ, which I formerly



ascribed to didymium, belongs equally to the new earth. Its centre falls between the first two of the four principal solar rays M; it extends about from λ=376 to λ=372; it is strong, but less distinct than θ. (5.) A ray ν, λ=364—360, a little before N; about equal to the former in intensity and in appearance. (6.) An analogous ray ω, whose centre coincides with the solar ray O; it is a little less easy to observe because the spectrum is generally faint in this region as well as in the extreme ultra-violet.

4. *Didymium.*—I have mentioned above that two of the rays which I had described as forming part of the spectrum of didymium belong in reality to the foregoing metal. I add that I have verified the absence of these two rays in solutions of didymium carefully purified for me by M. Lecoq de Boisbaudran. Thus in the violet and ultra-violet portion the rays of didymium are reduced to the fine ray, a little after G, λ=427·5; a broad band between N and O, presenting two principal maxima of intensity, λ=353 and λ=348; lastly, a paler band, λ=330·5—328·5, a little before Q.

On Erbia.—P. T. Clève.—True erbia, characterised by its absorption-spectrum and by its fine red colour, has at last, after an exceedingly long and troublesome process, been obtained in such a degree of purity as to permit of the exact determination of its molecular weight. The method which I have made use of consists in the partial decomposition of the nitrates by heat. I have not been able to discover another process. The purest erbia which I have been able to obtain still shows traces of the absorption-rays of thulia, and of the earth X (holmia) I have made long, but vain, attempts to separate them completely. It was not difficult to separate entirely one of these earths, but only by the sacrifice of a considerable quantity of material, and in the erbia thus freed from one of these earths there were still found traces of the other, and for the separation of the latter, also, the quantity of material which I possessed was not sufficient. The quantity of true erbia in the old erbia is not so considerable as that of ytterbia, which formed the bulk of the erbia obtained by Bunsen, Höglund, &c. The traces of thulia and of the earth X present in my erbia could not exert any appreciable influence on the atomic weight. I divided the earth by the partial decomposition of the nitrate into four fractions, and I determined the molecular weight of the two extreme ... fractions. The first gave for the metal (Er) the atomic weight 166·25; the last, 166·21 and 166. I have several times obtained the number 166 on determining the atomic weight of the purest fractions. I believe that this number is exact, or that it differs from the truth merely by a few tenths of unity. It differs from the atomic weight of ytterbium, 173, by 7 units. Erbium oxide is a powder of a most beautiful and pure rose colour, which it preserves even after strong ignition. It dissolves slowly in acids, unless they are very concentrated. Its specific gravity, as determined by M. Petterson, is 8·64. Its salts have also an intense and beautiful red colour. The nitrate, $Er_2(NO_3)_6+10H_2O$, forms large crystals, permanent in the air. The sulphate crystallises with 8 molecules of water. The double potassium sulphate, $Er_2K_2(SO_4)_4+4H_2O$ is very soluble in cold water, as is also the corresponding ammonium salt. The selenite, $Er_2O_3,4SeO_2+5H_2O$, is precipitated in a crystalline form on adding alcohol to the mixed solutions of selenious acid and erbium nitrate. The oxalate, $Er_2(C_2O_4)_3+9H_2O$, is precipitated from a hot acid solution in red microscopic crystals. The formiate is obtained on adding erbium oxide to boiling formic acid as a red powder, scarcely crystalline. It is anhydrous, and dissolves slowly in water. This solution on evaporation over sulphuric acid gives a viscid mass, which solidifies after a time. If the solution is abandoned to spontaneous evaporation beautiful red crystals of the hydrated formiate are obtained. The platino-cyanide, $Er_2Pt_3(CN)_{12}+21H_2O$, crystallises like the yttrium salt in red prisms, showing on some of their surfaces violet reflections, but a metallic green on their prismatic and pyramidal planes. The composition of the selenite, of the double potassium and ammonium sulphates, and the proportion of water in the simple sulphate, prove that erbium oxide should be written Er_2O_3.

Measure of the Intensity of certain Dark Rays of the Solar Spectrum.—M. Gouy.—The application of the author's method (*Comptes Rendus*, Dec. 15, 1879) gives the following results, the unity being ten-millionth of a millimetre :—

	Intensity.
Ray *c*	1·1
Ray *b*	0·9
Ray 4957 (Angström)	0·45

Group B between the wave-lengths 6866 and 6880, in the same afternoon :—

h.	*m.*	Intensity.
2	30	2·8
4	30	3·5
5	10	4·3
5	35	4·7

NOTES AND QUERIES.

Soft Water.—(Reply to "D. D.")—At St. Valery, Hastings, is a large supply of rain-water. The town water has only 8 degrees of hardness. Distance from London, 60 miles, S.E.R.—G. A. KEYWORTH.

THE JOURNAL OF SCIENCE

for OCTOBER (Price 1s. 6d.), includes—

The Vehicle of Force. By Charles Morris.
Exploration in the Far East.
The Phenomena of Fluorescence. By E. R. Hodges.
Gilbert White Reconsidered.
The Four Forces in Nature. By G. Whewell, F.I.C.
Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.
The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.
Especial facilities or persons preparing for Government and other examinations.
Private Pupils will find every convenience.
Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.
Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

MR. J. S. MERRY,
ASSAYER AND ANALYTICAL CHEMIST,
SWANSEA.

ROYAL POLYTECHNIC.—Asmodeus, the Bottle Imp. Ventriloquism and Magic, by Professor Hellis. Modern and Machine Guns, the New Forest, the Oxy-hydrogen Microscope, &c., by Mr. J. L. King. Musical Entertainment by the talented Adison family. Sights of London, by Mr. Heath. Blondin and Leotard, the marvellous Automata. Diving Bell, Moving Machinery and Models. The Royal Polytechnic Barometer, &c. Stokes on Memory, Tuesdays and Thursdays at 7. Open 12 till and 7 till 10. Admission 1s.

MOTTERSHEAD & CO.,
7, Exchange Street and 10, Half Moon Street,
MANCHESTER.

CHEMICAL & PHYSICAL APPARATUS,
BOTTLES, PURE CHEMICALS,
REAGENTS, STANDARD SOLUTIONS,
And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

GREENBANK ALKALI WORKS COMPANY
(LIMITED),
ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{2}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

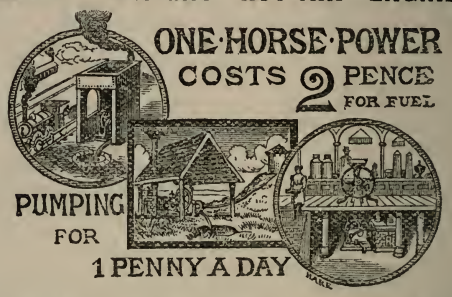
PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

THOMAS ADKINS & CO.,
SMETHWICK,
NEAR BIRMINGHAM

MANUFACTURERS OF SPECIALLY PREPARED RED LEAD FOR FLINT-GLASS MAKING.

BAILEY'S PATENT HOT-AIR ENGINE.



Made from ¼ to 5 horse-power. 56lbs. of coke will keep a 1-horse going 12 hours. 1000 galls. of water lifted 50 feet high for a penny.
NO BOILER. NO DANGER.
Awarded Prize Medal by the chief Societies.
SOLE MAKERS—
W. H. BAILEY & Co., Albion Works, Salford, Manchester.

SILICATE OF SODA, Solid and in Solutions of Various Degrees of Concentration: the finest quality obtainable, and especially adapted for the use of Soap Makers and other Consumers.—JOSEPH CROSFIELD and SONS, Soap Makers, &c., Warrington.
London Agent—H. B. CLARKE, 37, Great Tower Street, E.C.

THE CHEMICAL NEWS.

Vol. XLII. No. 1091.

A NEW PROCESS FOR THE METALLURGIC TREATMENT OF COMPLEX ORES CONTAINING ZINC.*

By EDWARD A. PARNELL, F.C.S.

The subject to which I have the gratification of inviting your attention, namely, the effective and remunerative treatment of certain complex ores containing zinc, has been an important problem in metallurgy. It is well known that the presence of zinc in considerable quantity in ores containing other metals, has a very injurious influence in the ordinary smelting processes for the extraction of the latter. In the case of copper ores, for example, the presence of much zinc necessitates additional operations in order to obtain copper of good quality; and all the zinc originally present in the ore is lost. Of still greater inconvenience is the presence of much zinc in lead ores, when the ordinary smelting processes are pursued; not only are the operations impeded thereby, but there is also a considerable loss of lead. Hence it follows that copper ores containing much zinc are rejected by the copper smelter, and lead ores containing much zinc are rejected by the lead smelter.

Further, ores of this complex character are not adapted to the use of the zinc or spelter manufacturer. From the peculiar character of his reduction process, in which the cost of earthen retorts form a considerable item in his working charges, it is essential that his raw material contain a considerable proportion of zinc: less than 25 per cent would be regarded as unsuitable. Not only so, but the presence of certain other metals, especially lead, is highly objectionable to the spelter maker from their injurious action on the earthen retorts. Zinc ore containing 8 per cent of lead would be discarded.

Hence the necessity of resorting to some means of separation before having recourse to the ordinary smelting processes. Of course the mechanical method of "dressing" is always adopted wherever it is practicable. In ordinary mixed ores containing galena and blende, this is easily accomplished by the great difference between the specific gravities of these two minerals; but in many cases separation by dressing is impracticable. Thus blende and copper pyrites resemble each other in density too closely to allow of separation by dressing. Again, blende and galena are often found so intimately mixed or combined (forming apparently a homogeneous mineral) that their separation by dressing is too difficult to be practised on the large scale; in fact, this is in some cases quite impossible. The plumbiferous blende found in Anglesea, commonly known as "bluestone" is of this character. Enormous quantities of copper ores also exist, the raising of which would be very profitable were it not for the contaminating influence of 20 per cent and upwards of zinc; but hitherto the highest prices paid for such by the smelter have been unremunerative to the miner. The cupriferous blende found in great quantities at Ain Barbar, in Algeria, is of this kind.

The extraction of zinc from such ores in a useful form has often been attempted by means of hydrochloric acid, after calcination of the ore, with the view of decomposing the chloride of zinc by lime. Serious impediments, however, to this method have prevented it from being adopted, especially the difficulty of washing the oxide of zinc from the chloride of calcium and obtaining it in a dense form, suitable for the spelter manufacturer; also, the injurious influence of the presence of chlorine in any form in the subsequent smelting of the residue containing lead and silver.

The separation of oxide of zinc from the calcined ore can of course be easily effected by sulphuric acid, but the great objection to this method has been the difficulty (hitherto generally considered insuperable on the large scale) of obtaining oxide of zinc from the sulphate, in a form suitable for the spelter manufacturer. In the process to which I would now invite your attention, this difficulty is completely overcome.

When heated alone, sulphate of zinc requires a very high temperature to effect its decomposition. Such a method is impracticable on the large scale; but when mixed with a small proportion of a deoxidising agent, sufficient to take one equivalent of oxygen from the sulphate, it is easily decomposed with the production of oxide of zinc and sulphurous acid. A mixture of 2 equivs. of zinc sulphate with 1 equiv. of carbon, heated to dull redness, affords oxide of zinc. With a larger proportion of carbon, sulphide of zinc is produced. Sulphide of zinc, whether artificial or native, is also well adapted for decomposing the sulphate. 3 equivs. of sulphate and 1 equiv. of sulphide produce 4 equivs. of oxide and 4 equivs. of sulphurous acid ($3ZnSO_4+ZnS=4ZnO+4SO_2$). Native sulphide of zinc is the reducing agent, which I prefer on the large scale for making oxide of zinc suitable for the zinc manufacturer.

I will now briefly describe the routine of operations at present pursued at the works of the Swansea Zinc Ore Company, which have been erected for carrying out the process on an extensive scale.

The principal ores operated on are the following, neither of which is "dressable."

1. Complex ore from Cavalo (Algeria), containing, as sulphides—Zinc, 17 p.c.; lead, 16 p.c.; silver, 20 ozs. per ton.

2. Cupriferous blende from Ain Barbar (Algeria), containing—Zinc, 23 p.c.; copper, 6 p.c.; silver, 6 ozs. per ton.

3. Complex ore from Italy, containing—Zinc, 20 p.c.; lead, 12 p.c.; copper, 5 p.c.; also silver.

4. "Bluestone" from Anglesea, containing—Zinc, 28 p.c.; lead, 12 p.c.; silver, 12 ozs. per ton; also gold and copper.

5. Ore from Constantine (Algeria) containing—Zinc, 12 p.c.; lead, 5 p.c.; copper, 1·5 p.c.; silver, 12 ozs. per ton; also gold.

After having been ground sufficiently to pass through a sieve of six or eight holes to the linear inch, the ore is calcined, with exposure to air, at a moderate heat. This calcination is effected in large muffle furnaces; the gas from which, when containing a sufficient proportion of sulphurous acid for making sulphuric acid, is conveyed to leaden chambers for that purpose. The sulphides of the various metals are thus converted into oxides and sulphates. A dull red heat is found by experience most favourable to the formation of sulphate of zinc; but it must be sufficient for the decomposition of ferrous and ferric sulphates. The calcined ore is next mixed with weak sulphuric acid in a revolving pan lined with lead (invented by Mr. J. W. Chenall); neutral liquors are first run off; afterwards excess of acid is introduced, and the acid liquors thus obtained, together with subsequent washings by water, are used for producing neutral liquors from a fresh charge of calcined ore.

The solution of sulphate of zinc thus obtained of course contains copper when that metal was present in the ore. Of iron it contains very little, provided the ore had been properly calcined, so as to peroxidise all that metal, the sulphuric acid combining by preference with oxide of zinc. I may mention, in passing, that a solution of ferric sulphate is decomposed when warmed with oxide of zinc, with precipitation of ferric oxide and production of sulphate of zinc.

* A paper read before the Chemical Section of the British Association, Swansea Meeting, 1880.

From the clear neutral liquor copper is next precipitated in the usual way, either as metallic copper by means of iron or zinc, or as sulphide. The solution of sulphate of zinc is then concentrated by evaporation, and mixed when it begins to thicken with finely-ground blende, in the proportion of one equivalent to three equivalents of zinc sulphate. This mixture, after being further dried, is lastly heated to redness in a muffle furnace. The mutual reaction which I have already described takes place with production of oxide of zinc and sulphurous acid. The latter, having no admixture of gases derived from the fire, is conveyed to leaden chambers for the reproduction of sulphuric acid.

The oxide of zinc thus obtained is in a condition well suited for the manufacture of metallic zinc in the ordinary way. Its strength and purity of course depend to some extent on that of the blende used as the reducing agent. When the latter contains about 45 per cent of zinc, the oxide as withdrawn from the furnaces contains about 62 per cent of zinc. It contains no impurity which is of any inconvenience in its application for making metallic zinc. The principal impurity is oxide of iron, derived partly from the blende added in the process, and partly from the use of iron as a precipitant for the copper. The impurity which the zinc manufacturer regards as most deleterious—namely, lead—is reduced to a minimum, being only the small proportion contained in the added blende. The same may be said respecting calcium.

Occasionally the oxide of zinc contains a little magnesium, owing to the presence of magnesian minerals in the raw ore. But this metal is not present in the oxide in the objectionable form of sulphate, but in the innocuous form of oxide. It may be interesting for me to remark here that sulphate of magnesia is easily decomposed by blende and other reducing agents in a manner corresponding to sulphate of zinc. When a mixture of single equivalents of sulphate of magnesia and carbon is moderately heated, magnesia is obtained mixed with very little undecomposed sulphate. Magnesia thus prepared corresponds in density to what is known as "heavy" calcined magnesia. It will be obvious that this method of preparing that article will be found far more ready and economical than the common method of precipitation as carbonate and calcination.

I have now to revert to the portion of the ore left undissolved after treatment with dilute sulphuric acid. This, of course, contains all the lead originally present in the ore. The same may be said of the gold and silver. It might be expected that a portion of the silver would be sulphated and rendered soluble during the calcination of the ore. This is doubtless the case to a small extent, but I have always found that the minute quantity of silver thus rendered soluble is less than corresponds to the trace of chlorine present in chamber sulphuric acid, and chloride of silver is quite insoluble in solution of sulphate of zinc.

For the further treatment of this residue the ordinary well-known smelting processes are resorted to, the products being argentiferous and auriferous lead, and also copper regulus, which generally contains both gold and silver. At the works of the Swansea Zinc Ore Co. the smelting of the residue is effected in cupolas; an important appendage to which is the lead fume condenser patented by Messrs. Wilson and French, of Sheffield (brought before the notice of the British Association last year), in which the gases from the furnace are forced under water and allowed to pass up through layers of fine copper gauze. I am happy to be able to state that this condenser is now being worked very satisfactorily.

In conclusion I would remark, as will doubtless have occurred to you, that this mode of treating sulphate of zinc is capable of other applications besides the complex ores I have referred to. Such, for example, as the residue of blende after the richer portion has been separated. Immense quantities of such residue exist containing 22 per cent of zinc, the further dressing of which is not profitable. This is of no value in its present condition, but capable of profitable application by the process I have described. It may also be applied to lead fume containing zinc, and to the crude sulphide of zinc derived from burnt iron pyrites containing blende, of which a large quantity is used in Germany for making sulphuric acid.

In reply to enquiries respecting the density of the oxide of zinc thus prepared (a matter of great importance to the spelter manufacturer), Mr. Parnell stated that it is rather greater than that of ordinary calcined calamine. The oxide is in every respect admirably suited to the manufacture of zinc.

ON A

NEW PROCESS FOR THE PRODUCTION, FROM ALUMINOUS MINERALS CONTAINING IRON, OF ALUMINIUM SULPHATE FREE FROM IRON.*

By J. W. KYNASTON, F.C.S., F.I.C.

(Concluded from p. 193.)

AFTER a long and tedious investigation, I found that arsenite of peroxide of iron is insoluble in cold solution of sulphate of alumina, if there be present in the solution a small proportion of the tetrabasic sulphate, and also a slight excess of arsenious acid. The presence of some tetrabasic sulphate in the solution seems to be essential, for the reason that carbonate of lime is the only substance which throws down the arsenite of iron. Lime itself, or even the caustic alkalies, do not render it insoluble; they produce in the liquid a deep reddish tint, but even after standing some weeks, there is little or no arsenite deposited. Carbonate of lime, on the contrary, instantly causes turbidity in the cold solution, and the arsenite of iron settles completely down. By the employment of these reactions, I found it to be possible to remove from a ferruginous solution of alumina practically all the iron existing in the ferric state, and to produce easily a sulphate of alumina from bauxite of a far higher degree of purity than has hitherto been produced from the finest quality of china-clay.

There remains, however, in sulphate of alumina so purified still a little iron in the state of protoxide, probably derived from some silicates or titanates of protoxide existing in bauxite. The proportion is about one-fourth of the whole iron contained in bauxite, so that by the arsenious acid and carbonate of lime reaction there is removed about three-fourths of the quantity present.

The removal of this ferrous iron for some time continued a great difficulty. Its separation from the alumina solution by the reaction with arsenious acid proved impracticable, inasmuch as all the ordinary oxidising agents which would peroxidise the iron converted the arsenious acid present into arsenic acid. Blowing air through the mixture was tried, but, even after prolonged blowing, scarcely a trace of iron was converted to the higher state of oxidation; and the attempt to effect its further removal by this means was abandoned. I then, almost hopelessly, resolved to try a well-known reaction for the removal of the protoxide of iron, a process first proposed to be used for this purpose, I think, by Robert Harvey, in a patent taken out by him in the year 1839. It will probably be correct to say that every worker on this subject has given more or less attention to this reaction, with a view to apply it for the separation of iron from aluminous solutions, for it is a reaction of so decided a character, and so well known to every tyro in chemistry, that it would naturally suggest itself as a means to accomplish the end in view. But just as it has

* Read before the Chemical Section of the Britis Association, Swansea Meeting, 1880.

been found impossible to devise an analytical process for the separation of iron and alumina by the application of this reaction, so every attempt to use it in the manufacture of sulphate of alumina free from iron has also failed, and the difficulty has been considered insuperable. The reaction to which I refer is that with ferro-cyanides, the production of the well-known precipitate of Prussian blue. The reason of the failure successfully to apply this reaction hitherto is that the blue precipitate obstinately refuses to fall out of the solution; and if the proportion of iron present approaches only one-half per cent of the sulphate of alumina, scarcely any alteration in the appearance of the blue mixture is apparent, even after standing at rest for several days, and even if the solution is made excessively dilute, and the mixture be allowed to stand at rest until the visible precipitate has settled out, the solution still retains a blue colour, absolutely irremovable by any process of filtration, and, when concentrated by evaporation, so as to obtain a solid sulphate of alumina, the product possesses a deep blue colour, and has, for this reason, no commercial value.

The Prussian blue precipitate is indeed a nasty slimy mud, and so finely divided that it remains to some extent in suspension in the fluid for an indefinite period.

Notwithstanding the difficulties in the application of this reaction, I have devised a means of using it for the purification of aluminous solutions which is perfectly successful, and which involves a curious physical change in the character of the blue precipitate which has not before been observed.

When to a solution of sulphate of alumina, purified from peroxide of iron by the arsenious acid process as already described, but still containing about 0·20 per cent of iron and the excess of arsenic used, there is added a quantity of ferrocyanide of potassium exactly equivalent to the iron present, after standing a few days, the greater part of the light blue precipitate settles out. If now there be passed through the blue supernatant liquid a current of sulphuretted hydrogen to saturation, the sulphide of arsenic formed carries down with it undecomposed every particle of the suspended blue precipitate, leaving a perfectly clear solution; and when this solution is concentrated by evaporation to the solidifying point, pure sulphate of alumina, of which we have been in search, is obtained, and the degree of purity is such that the product can be used for nearly all purposes for which the crystallised alums have been required.

There is, however, in this process some loss of ferrocyanide, which under certain circumstances may be considerable, and which it is desirable to avoid. This led to the further prosecution of the investigation, and having found that a precipitate of sulphide of arsenic formed in the solution carried down with it the whole of the suspended blue precipitate, it seemed probable that another similarly flocculent precipitate produced in the liquid would effect the same purpose. The plan that naturally suggested itself was to add to the alumina solution a slight excess of ferrocyanide beyond that required to combine with the iron salt, and then sufficient solution of sulphate of copper to react upon the excess of ferrocyanide. The process gave the expected result. The minute quantity of flocculent ferrocyanide of copper apparently embraced within its grasp the previously imponderable blue precipitate, and the whole quickly settled down, leaving a clear, bright, colourless solution.

But further experience with these reagents soon led to a surprising and unexpected result. It was found that the addition of only a trace of copper, or even of zinc salt, to the aluminous solution, free from any excess of ferrocyanide, caused an aggregation of the particles of imponderable blue precipitate, and so altered its physical condition that it separated perfectly from the liquid, leaving it clear and colourless. The blue mixture, in which there was apparently no distinct precipitate, after the addition of an exceedingly small proportion of either copper or zinc salt, assumed the appearance of a colourless liquid, in which floated aggregated particles of Prussian blue. Thus there was produced a perfect separation of the whole ferrocyanide, which, by an easy process, could be re-converted into a soluble form, again to be used for the separation from aluminous solution of a further quantity of iron.

That the change in the condition of the blue ferrocyanide produced by the addition of a mere trace of copper salt is not owing to chemical decomposition of the iron salt, seems to be proved by the fact that the addition of a large excess of copper salt to freshly precipitated Prussian blue does not destroy its blue colour, whereas the opposite reaction does take effect, a precipitate of copper ferrocyanide suspended in liquid being, after some time, completely decomposed by an excess of iron solution. The change in the condition of the precipitate is, therefore, probably only a molecular alteration.

The reactions I have brought to the notice of the section in the foregoing rather lengthy disquisition have recently been applied to the commercial production of pure sulphate of alumina on a considerable scale, the plant just completed by the St. Helens Chemical Company being now equal to a weekly production of twenty-five tons, and it is in contemplation to increase it to double this quantity, or fifty tons per week.

A short description of the actual process of manufacture may not be unacceptable to the section:—Into a large lead-lined iron tank, placed at a high elevation, is ran about 48 cubic feet of sulphuric acid of 145° T., just in the condition in which it issues from the Glover Tower in the ordinary process of manufacture. Steam is blown into this until it is near the boiling point, and the strength is reduced to from 90° to 95° T. whilst boiling hot. A charge of 26 cwts. of bauxite finely ground, having been previously got ready, is thrown into the hot vitriol until 20 cwts. have been added, then 3 cwts. more, previously mixed with 140 lbs. (or about five per cent of the weight of the charge of bauxite) of common white arsenic is added, and lastly the remaining 3 cwts. of bauxite.

After the addition of from 8 to 10 cwts. of bauxite the mixture commences to swell, until it reaches to six or eight times its original bulk, and the bauxite is then more slowly added, each further addition causing a renewal of ebullition. To moderate the violence of the reaction, it is sometimes necessary to run in a little cold water; but if proper caution be observed this is unnecessary. As the reaction approaches completion, the mass subsides in the vessel, and, when a state of perfect quiescence is attained, steam is blown in for about half an hour, after which a quantity of hot water is added, so as to prevent the thickening of the mass, and then sufficient cold water to reduce the mixture to about 40° T. when cold. There is then thrown in 200 lbs. of common chalk, previously mixed with water to a thin cream, and passed through a fine sieve, and the whole is thoroughly agitated. The operation is now complete. The muddy batch of liquid, which contains in solution about 4 tons of sulphate of alumina, is ran off into one of a series of lead-lined tanks standing just on a lower level than the dissolver, and of such capacity that the batch fills it within a few inches. Here it is allowed to remain for from 12 to 14 days; but after 3 or 4 days, or when quite cold, a sample is taken, to which a little of the chalk mixture is added, and if this produces a deepening of the yellowish tint, more chalk is added to the batch, and this is continued until the addition of more chalk produces no alteration.

When the supernatant liquid is quite clear and bright it is drawn off into one of the second series of tanks, each of the same capacity as the first, placed on a still lower level, and the arsenite of iron is found at the bottom of the tank, superincumbent on the heavier mass of undecomposed bauxite, silica, &c., beneath.

The partially purified liquor now almost constantly contains in a cubic inch, which is equal to about 110 grains of sulphate alumina, 0·20 grain of iron as protoxide.

To each batch there is now added a quantity of solution

of ferrocyanide of calcium, equivalent to the iron present, and, after 24 hours, 7 or 8 lbs. of sulphate of copper or sulphate of zinc ; the mixture is thoroughly agitated, and allowed to stand until the Prussian blue has deposited, which requires 12 to 14 days. The colourless, or slightly blueish liquid, now free from iron, is drawn off to a stoneware tank, and the blue mud is passed to a wooden filter press, and the ferrocyanide well washed with water within the press. The pressed cake is removed from the press, broken up with water, and steam is blown into the mixture. Milk of lime is then added until the blue colour is entirely destroyed, and a solution of ferrocyanide of calcium is obtained ready for the purification of another batch of aluminous solution.

The solution of sulphate of alumina, now containing only as an impurity the excess of arsenious acid used in the process, is agitated in a stoneware vessel, and sulphide of calcium, obtained by heating together, in a gas retort, plaster-of-Paris and coke, is gradually thrown in. The arsenic is completely removed as sulphide, together with the trace of copper. The now pure solution is boiled down until the density reaches 106° to 108° T., whilst boiling hot, ran into leaden trays in which it solidifies, and the process is complete. The result is a sulphate of alumina practically free from iron, containing no free acid, and in which the percentage of alumina reaches 15 to 16, or about one-half more than that contained in the ordinary crystallised potash salt.

Before concluding my paper, I should like, with the permission of the meeting, to add, that the economical production of this pure sulphate of alumina will probably lead to the extensive prosecution of a comparatively new industrial application of salts of alumina.

In a paper, published in the year 1869, by Dr. Wallace, of Glasgow, he pointed out that in the manufacture of beet-root sugar, syrups are found containing large quantities of potash salts, and that the presence of these salts prevents the separation of a considerable proportion of the sugar by the usual process of crystallisation. According to Dr. Wallace, the proportion of these salts in beet-sugars, such as are used by refiners in this country, varies from 1 to 4 per cent, and in extreme cases contains even a larger quantity, and it is said that every 1 per cent of these salts prevents the crystallisation of 5 per cent of cane-sugar. Another great authority on beet-root-sugar, viz., Walkhoff, wrote in 1871, directing attention to this subject. He says that a process for successfully eliminating the alkalies from saccharine solutions would completely renew the face of the sugar industry and assure its future.

The investigation of the subject by the Messrs. Newlands, of London, led to the discovery by them that the elimination of potash from solutions of sugar could be readily effected by means of sulphate of alumina, the addition of this substance giving rise to the production of potash alum, which deposits from the sugar solution in minute crystals. In 1875, in conjunction with these gentlemen, Mr. James Duncan, the eminent sugar refiner, of the Victoria Docks, London, took out a patent to secure the process, and it has since been used by him most successfully, and at the present time he is producing potash alum at the rate of 1000 tons per annum, the whole of the potash required being extracted from sugar solutions by means of sulphate of alumina. Although, however, many of the principal refiners of the United Kingdom, and several other refiners in Holland, Belgium, and the United States, have taken out licenses to work the process, still it is not used to any extent elsewhere, and, so far as I have been able to ascertain, the sole reason for this abstention is the difficulty of obtaining sulphate of alumina sufficiently pure to prevent contamination of the sugar solutions. At the works of Mr. Duncan, a ferruginous sulphate of alumina is used, and afterwards the iron introduced into the sugar is removed by precipitation as sulphide by means of sulphide of calcium, which adds materially to the difficulty of the process.

Thus it appears that the economical production of pure sulphate of alumina will not only effect a saving of the immense quantity of potash now applied specially to the production of alum, but will open up a new and hitherto untapped source of wealth, in the extraction of this valuable base from saccharine solutions.

ON THE CONSTITUTION OF ULTRAMARINE.*

By H. ENDEMANN, Ph.D.

MANY have been the attempts to account for the peculiar and high colour of ultramarine. Some have looked upon certain impurities as the actual bearers of the colour (iron sulphide), others speak of a blue modification of sulphur, and others again of silicium and aluminium sulphide in very fine dissemination throughout the mass, but without chemical combination with the balance of the constituents. Lately, apparently, it has become a matter of taste to abandon entirely the discussion of the derivation of colour. The statement is made that this question cannot be decided, that it is impossible, for instance, to state why certain salts of cobalt are red and certain salts of copper blue. Nobody has attempted to decide why certain copper salts are blue, but it must be acknowledged that in dealing with certain compounds of copper of blue colour, constitutional peculiarities may be readily recognised in all of them, by which they may be easily distinguished from other salts of copper which are colourless. The colour of the salt in doubtful cases is a very positive indicator with regard to the type from which the constitutional formula should be derived.

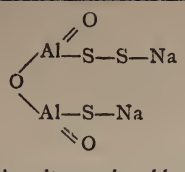
We are justified in insisting upon and foretelling for a coloured compound an unusual grouping of the atoms, if its constituents, otherwise under hitherto accepted arrangement of the atoms, would produce but colourless compounds.

If, in ultramarine, we consider the proportion of aluminium, silicium, and sodium, to the non-metallic constituents, oxygen and sulphur, we find an excess of the latter. It becomes necessary to ascertain and utilise this excess in the construction of the constitutional formula.

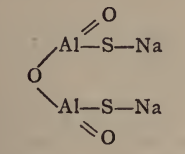
Aluminium is regarded as a four atomic element. All ordinary aluminium compounds are assumed to contain two aluminium atoms linked together by two of their atomicities, leaving six atomicities for combination with other elements. There is a possibility of the existence of compounds without this binding of two atoms by one atomicity,—a possibility that compounds derived from the as yet unknown compounds AlO_2 and Al_2O_4 may be prepared.

Considering the composition of ultramarine blue, we find that it consists of silica, soda, alumina, sodium monosulphide, and sulphur, the latter also in chemical combination, as it cannot be removed by solvents unless these act chemically at the same time. Most authors consider it as being united with sodium sulphide, forming polysulphurets. These substances forming ultramarine, I do not, however, consider as serving all the same purpose. To simplify the explanation, I propose for the present to regard one portion of the soda and alumina and the whole of the silica, merely as a vehicle necessary for the preparation and existence of ultramarine as they serve to facilitate the reactions in the first instance, while later in the process they may act in protecting the product against too powerful oxidation. This silicate may have a varying composition, and for this reason alone it would be difficult to correctly ascertain its quantitative relation to what may be called the colour nucleus, *i.e.*, the last group on the constitution of which the colour of the ultramarine depends. This we can suppose in ordinary ultramarine blue to be:—

* Read before the American Chemical Society, October 7, 1880.



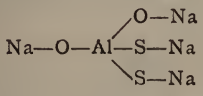
and in Heumann's ultramarine blue (*Liebig's Annalen*, 203, 190):—



The first of the two, under the influence of acid, will give two-thirds of the sulphur as such, while one-third will be obtained as H_2S. The latter (Heumann's) will give half as sulphur and half as H_2S.

While, therefore, Heumann's ultramarine-blue must be considered the purest, we see that ordinary ultramarine-blue may contain more sulphur in chemical combination. How much sulphur may thus be added greatly depends upon the process of manufacturing the ultramarine, as I will show hereafter. A substance may therefore be a good blue, and yet analysis will give no fixed relations between the *a* and *b* sulphur, as mixtures of ultramarine rich and poor in sulphur may exist, and many analyses, which have been not generally accepted as correct, should not be rejected, provided the method of analysis, which has been used, allows safe deductions to be made.

I. *Ultramarine White.*—The mother substance in the manufacture of blue ultramarine is ultramarine-white. To it, as it is white, I assign a constitution analogous to that of the neutral sodium silicate, a portion equal to half of the oxygen being substituted by sulphur.

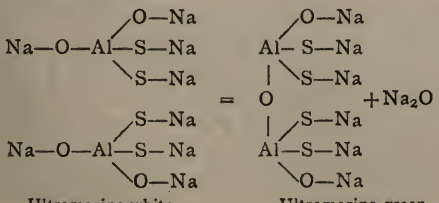


This constitutional formula includes the possibility of partial substitution of the aluminium by silicon. In the formation of ultramarine-white, the presence of the large quantity of sulphur and soda appear as the cause of the breaking of the bond between the two aluminium atoms in alumina. Two molecules of this substance acted upon by acids and water will yield 1 sulphur and $3H_2S$, which corresponds with the best ultramarine-white prepared (Ritter). Most ultramarine-whites yield by the action of aqueous acids more free sulphur, but it will be readily seen that the above formula allows a ready interpolation of furthur sulphur atoms. Dry hydrochloric gas acting upon two molecules of ultramarine-white produce directly ultramarine-blue, chloride of sodium, water, and sulphuretted hydrogen.

$$Al_2Na_8O_4S_4 + 6HCl = Al_2Na_2S_2O_3 + 6NaCl + H_2O + 2H_2S.$$

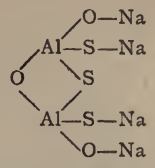
By the action of sulphurous acid gas ultramarine-white is first converted into ultramarine-green, two atoms grouping together under loss of Na_2O, forming the first coloured compound:—

II. *Ultramarine-Green*:—



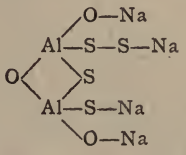
Ultramarine-white. Ultramarine-green.

which then, by the action of oxygen, which forms sodium sulphate, under further loss of Na_2S, passes into the jet-green compound—



Aqueous acids with the first greens would produce $3H_2S$ to S, and with the second green $2H_2S$ to S. It is well known that ultramarine-green contains rarely, if ever, the sulphur in such distribution; but this is easily explained by the assumption that these are derived from a white containing interpolated sulphur.

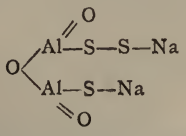
It is even possible that by the combined action of oxygen and sulphurous acid an interpolated green may be obtained, the sulphur for the sulphate being then furnished by the sulphurous acid, so that in this case but sodium is removed, leaving—



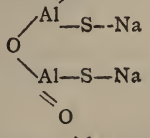
which compound, with aqueous acids, would yield $2H_2S + S_2$.

Gaseous dry HCl would produce all of these compounds, sodium chloride, and H_2S, leaving the blue on treatment with water in the insoluble residue, but this gas has perhaps rarely been used free from air and moisture, and the consequence has been that the reaction is generally accompanied by secondary ones. One of these would be that the mass would not lose so much in sulphur as is indicated by the above-stated reaction. Another is indicated by the presence of aluminium chloride in the wash-water, which is no doubt produced by water, which is produced by the action of air on the hydrochloric gas. In the formation of blue from white directly, water is one of the products of the reaction, and in this case the formation of aluminium chloride is therefore unavoidable, and this substance is therefore a regular concomitant of the reaction.

III. *Ultramarine Blue* is in the manufacture produced by the action of sulphurous acid and oxygen on the green. Thereby more sodium is removed, and the middle sulphur interpolated in one of the groups ending with Na. The sodium is converted into sulphate. The action of chlorine will produce the same product, leaving—



This product should yield with aqueous acids $H_2S + S_2$. Hydrochloric acid gas would form H_2S, 2NaCl, and



which latter substance, with aqueous acids, would yield $H_2S + S$.

This is Heumann's ultramarine blue, which in this purity has only once been prepared, owing undoubtedly to the superior care used by Heumann in the production of this compound. Further removal of sodium, and perhaps

partial substitution of sulphur by oxygen, seem then to form the violet, the so-called red, and the yellow. I could so far not find sufficient analytical data to justify formulæ for these compounds.

It is an accepted fact that if the presence of both silica and alumina for the manufacture of ultramarine is not absolutely necessary, it at least will greatly facilitate the reaction, and there is therefore a possibility not only that silica may introduce the reaction, but also that it may participate in the formation of the atomic complex, which is the cause of the colour. To what extent this is done on the ultramarines deficient in silica we cannot easily ascertain. It is certain, however, that silica will tend to increase the evolution of sulphuretted hydrogen, when such ultramarines would be acted upon by aqueous acid.

Such partial substitution may also be the cause for the varying proportions in which *a* and *b* sulphur are found to exist in the various ultramarines.

As regards the silicate next, I will quote here an analysis, made about 3 years ago for the American Ultramarine Works, which gave the following results :—

		Atomic Weight.		Atomic Relation.
SiO_2	39·28	:	60	0·655
Al_2O_3	26·41	:	102·8	0·257
Na_2O	20·83	:	62	0·336
S	12·98	:	32	0·406

The sulphur being in two forms, two-thirds being obtained as S while one-third was obtained as H_2S, we divide 0·406 by 3, which gives 0·135 = 1 atom of sulphur. For S_3=0·406 we require Na_2O=0·135, and Al_2O_3=0·135 for the colour nucleus. This leaves for the silicate—

Na_2O	0·201
Al_2O_3	0·122
SiO_2	0·655

or about $3Al_2O_3,5Na_2O,16SiO_2$.

This is certainly a somewhat disagreeable rest in itself to deal with, without trying yet to add to it the colour nucleus, to obtain one formula for the whole of the substance, which we call ultramarine. Moreover, almost every sample will be found to differ from the other even from the same factory, and of course more yet when products of different factories should thus be compared.

As far as I know, in the United States, only ultramarine rich in silica is prepared, and as only in those poor in silica the whole series of compounds which are necessary for the thorough study of the genesis of ultramarine are readily recognised, I found myself unable to contribute any new facts, but had in the construction of the formula to rely only on the excellent work which has been done by chemists more favourably situated.

The literature of ultramarine contains quite a series of analyses in minute details, but not one single investigation follows quantitatively all the stages of transformation throughout the whole series of possible compounds.

Such an investigation of course would merely prove that the relation of the sulphur and oxygen to aluminium and sodium were or were not in the ratio indicated.

I would not demonstrate the actual existence of compounds as those assumed by me.

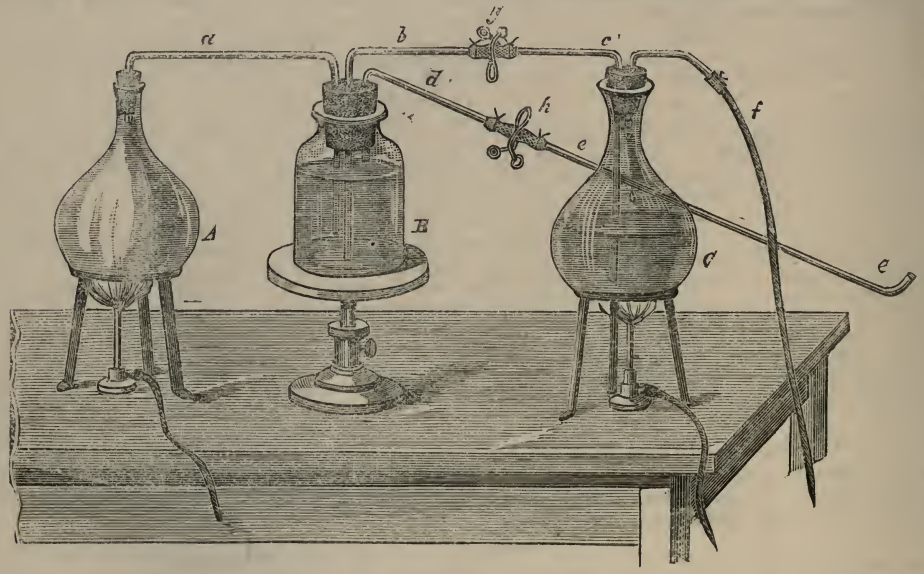
The possibility of the existence of such compounds will have to be proven in a more direct manner. Experiments which I have made so far to substantiate this theory have not led to any positive results.

ON BUNSEN'S METHOD FOR DETERMINING FREE OXYGEN IN WATER.

By J. KŒNIG and C. KRAUCH.

THE gases are expelled from the water and collected by means of the following apparatus (*Zeitschrift Anal. Chemie*, fig. 17, p. 260, 1880). The use of this apparatus is exceedingly easy and convenient.

The vessels B and C are filled (the former entirely, the latter only half), with water which has been boiled for some time so as to be free from air. The glass tubes, *a*, *b*, *c*, are also filled by blowing into the flask, *c*, and opening the pinch-cock, *g*. The flask A is then entirely filled with water which has been thoroughly boiled, and is free from air, and quickly connected with *a*. If, whilst effecting the



connection, we close the pinch-cock *g*, the stopper is generally spontaneously pressed into the flask A, the water of which is colder than that in B and C. The flask A is then boiled for some time, which brings the water in B also to a boil and after opening *g*, it is driven into the flask C. When this has taken place entirely or partially the gas flame is removed from under A. In consequence of the cooling the water flows back from C into B and A. The air which is still present collects underneath the stopper in B,

and is expelled by opening the pinch-cock *h*, and blowing into the flask C.

This boiling and driving the water backwards and forwards from A and B into C is continued before every determination till no more air collects in B. When this is effected the pinch-cock *g* is closed, the flask A is quickly removed, emptied, and filled entirely with the water under examination. During this operation a little air always enters into the tube *a*, but by closing *g*, and blowing air into C, *a* can be easily and entirely re-filled with the de-aërated water, and when the stopper is quickly placed in the flask A, which has been entirely filled with the water to be examined, on simultaneously opening the pinch-cock *g*, A may be connected with B in such a manner that not a bubble of air enters. A is next heated to a boil, leaving *g* open, when the air present in the water, mingled with watery vapour, passes into B. The boiling in each case must, however, not be continued till all the water in B has been driven through the tube *b* (which reaches to its bottom) into C, as then some of the air would also be expelled.

When the water in B has been expelled down to about the middle of the vessel the flame is removed from beneath A, whereby water passes again from C to B and A, whilst the expelled air collects in B underneath the stopper; as soon as A is entirely filled with water the boiling is resumed and repeated in the same manner from 6 to 10 times. When the air has thus been completely expelled from the water in A—which is very difficult and can scarcely be effected with quantitative accuracy—the flame is removed from A, which is allowed to fill itself again with water, the pinch-cock *h* is opened, and the air which has collected in B is driven by blowing into C completely out of B through the tube *d e* into the eudiometer. This can be easily and accurately effected. A certain quantity of water is indeed carried along into the tube of the eudiometer, but this serves to dissolve the solid potassa which is introduced in small fragments in order to absorb the carbonic acid present in the air. When no further decrease takes place the volume of the air is measured, noting the indications of the barometer and thermometer. In order, in this mixture of nitrogen and oxygen, to determine the latter, a concentrated solution of pyrogallic acid is employed, which is left in contact with the air for several hours, frequently agitating the tube.

The level of the pyrogallic solution and the column of mercury are measured, and like the water pressure reduced to mercurial pressure. In calculating the volume of gas at 0° and 760 m.m. pressure the tension of the vapour of pure water is assumed, and not that of the potassic solution of pyrogallic acid. This assumption is not quite accurate, as the potassic solution has a somewhat higher specific gravity than 1, and its tension is less than that of pure water. As in the first case too small a quantity is subtracted from the barometric reading, and in the second case too much, the trifling error is compensated. Where great accuracy is required the sp. gr. of the potassic solution should be determined. (See also "Bunsen's Gasometric Methods," 2nd edition. 1877, p. 387).—*Zeitschrift Anal. Chemie.*

PROCEEDINGS OF SOCIETIES.

THE AMERICAN CHEMICAL SOCIETY.*

The regular meeting of the Society was held, September 9th, 1880, at University Building, Washington Square, New York. The following papers were read:—

"*Displacement of the Absorption-Bands of Purpurin in Solutions of Alum.*" By Henry Morton, Ph.D. This paper drew attention to the fact that the position of the two principal absorption-bands of purpurin dissolved in alum solution was notably affected by the amount of alum in the solution. Thus, a solution of alum containing 2 per cent of the salt showed the bands at conspicuously lower points than a solution containing 1 per cent, and this again showed a lower position than a solution containing half per cent. The change seems to be gradual and to amount to a depression of the bands by addition of alum to the solution, everything else remaining the same. A similar depression was also found to be caused by heating these solutions, the band returning as they cooled. Soda, potash, and ammonia alums, and sulphate of alumina were used and found to operate similarly. In the discussion which followed the reading of this paper, Dr. Morton remarked that the displacement was towards the red end of the spectrum. In two cases the observations were 50°·26′ and 50°·27′ when cold, and 50°·20′ and 50°·21′ when hot. Dr. Morton also remarked, that the heat employed in the experiments did not destroy the purpurin.

"*Examination of the Raw Materials used for Arita Porcelain.*" By Nawokichi Matsui, Ph.D., of the School of Mines, Columbia College. The samples which form the subject of this examination came from Koransha, a large porcelain manufacturing company of Arita, in the province of Hizen, Japan. As this locality has been the great centre of this industry in Japan for about three centuries, the examination of the raw materials used there will also give a tolerably good idea of those generally used in Japan. The native minerals used in the manufacture are all white, varying considerably in hardness, and apparently showing different stages of the decomposition of the felspathic rocks. The larger part of this paper is occupied with the results of the analyses of the sixteen different materials used in the manufacture, and also with the results of determinations of specific gravity and fusibility.

* Communicated by Arthur H. Elliott, F.C.S., Recording Secretary.

NOTICES OF BOOKS.

The Laws of Health. By W. H. Corfield, M.A., M.D., &c. London: Longmans and Co.

This useful manual contains, along with much sound information and valuable advice, some matter which is at least questionable. Thus under the head "Tea, Coffee, and Chocolate" the author writes:—"In almost all countries the inhabitants have prepared decoctions from these plants, or from others possessing similar properties. They resemble all vegetable decoctions in containing an astringent substance called tannin." Now in the published analyses of the cacao-bean, freed of course from its husk or shell, and also of chocolate, we find no mention of tannin. His condemnation of the use of tea and coffee at meals is on chemical principles perfectly just. The "tea-dinner" is a fruitful cause of indigestion and debility, especially among women of the poorer classes.

We are glad to find that Dr. Corfield bestows on the intermittent system of water-supply his full condemnation.

With the author's remarks on the disposal of sewage we cannot agree. We wish that those who so perseveringly uphold irrigation—especially in a country where the soil and the atmosphere are often too moist for the most important crops—would for once endeavour to refute, if they can, the experimental evidence obtained by Mr. Smee, jun., on the ready putrescence of plants raised by sewage irrigation.

Tables for the Analysis of a Simple Salt for Use in School Laboratories. By A. Vinter, M.A. London: Longmans and Co.

This little work belongs to that class of elementary chemical treatises which are the despair of the critic. They

are on a level with the knowledge of the day, and patient examination fails to detect in them any errors. As little does it, unfortunately, reveal any reason for their existence, or show any distinct advantage which one of these books possesses over others.

There are numbers of coal-tar colours which are beautiful, pure, easy of application. But dyers will not use them because they have no tangible superiority over other colours which are in general employment. Consequently the colour-makers decline to manufacture such compounds. Might not teachers of chemistry act on the same principle, and use old manuals, handbooks, and outlines till they can produce something decidedly better than what has gone before?

Spirit-Gravities, with Tables. By THOMAS STEVENSON, M.D. London: J. Van Voorst.

THESE Tables show in parallel columns the specific gravities of dilute alcohol at 60° F., water at 60° being = 1; the respective percentages of alcohol by weight and by volume; and the percentages of "proof-spirit." The question may be raised, what good end is served by retaining the notion of proof-spirit, a mixture of 49·24 per cent alcohol by weight with 50·76 water? Dr. Stevenson gives a history of previous tables, and of the experiments upon which they were based. He speaks in very laudatory terms of the researches of Gilpin, which, though made as early as 1790-94, were conducted with the utmost nicety, "every source of error which even the science of the present day points out being avoided, except that the weighings were not reduced to a vacuum"—a source of error which only affects the fifth decimal in the gravity. Tralles, who in 1811 was invited by the Prussian Government to reconsider the question, and whose tables are in official use over a great part of the Continent, pays the highest compliment to the accuracy of Gilpin's work. The tables of Fownes, drawn up in 1847, are pronounced less accurate than those of Gilpin. Mr. Hehner has published a set of alcohol tables based upon those of Fownes, but his numbers are said to be inaccurate to the extent of nearly ½ per cent of proof-spirit.

Dr. Stevenson's tables will prove exceedingly useful for public analysts.

Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1878. Washington: Government Printing-Office.

THE principal event mentioned—now, of course, no longer recent—is the death of the illustrious physicist, Prof. Joseph Henry, for many years Secretary of the Institution, and the election of Prof. S. F. Baird as his successor. The report contains a biographical memoir of Prof. Henry, by Prof. Asa Gray, and a catalogue of the memoirs and papers (149 in number) which the deceased had communicated to learned societies, scientific journals, &c.

We have, further, biographies of Condorcet and of Louis Agassiz; papers on Prof. Henry's share in the development of the telegraph; on the "Effects of Irritation on a Polarised Nerve," by Dr. B. F. Lautenbach, and a posthumous memoir by Prof. Henry, entitled "Researches in Sound, with especial reference to Fog-Signalling," drawn up for the United States Light-House Board.

Qualitative Chemical Analysis. A Guide in the Practical Study of Chemistry and in the Work of Analysis. By SILAS H. DOUGLAS, M.D., and A. H. PRESCOTT, M.D. Third Edition, wholly revised. With a Study of Oxidation and Reduction by OTIS COE JOHNSON. New York: Van Nostrand.

THE most novel and interesting part of this work is Mr. Johnson's "Study of Oxidation and Reduction" which is given as an appendix. The author commences with a table in which a number of bodies are arranged according to their mutual oxidising or reducing action. The acids are placed in order of the atomic weight of the element in each which suffers oxidation or reduction, whilst the bases follow the usual analytical groups. The word "bond" is used in a novel sense to signify the amount of reduction it is capable of sustaining. He defines a bond as "oxidising force" and if an element has no oxidising power it has no bonds. If its only efficacy is that of a reducing agent its bonds are represented by a negative number. To ascertain the bonds of an element a series of rules are given. Hydrogen in combination has always one bond and it is positive; oxygen in combination has two always negative. Free elements have no bonds. The sum of the bonds of any compound always = 0. Acid radicals are always negative, the bonds of the radical being equal to the number of atoms with which it is capable of combining. Metals in combination are commonly positive, their hydrogen compounds being the chief exceptions. Oxidising agents increase the bonds of some other substance whilst reducing agents diminish it. The oxidation of any substance involves the reduction of some substance. From these principles the author derives a rule for writing equations so that every equation involving oxidation may be balanced at once if the products formed are known. The number of bonds changed in one molecule of the oxidising agent shows how many molecules (or atoms, in the case of free elements) of the reducing agent must be taken. Thus $2HNO_3+3H_2SO_3=3H_2SO_4+2NO+H_2O$ The nitrogen in HNO_3 has five bonds and in NO it has but two, losing three. Therefore three mols. H_2SO_3 must be taken. The sulphur in H_2SO_3 has four bonds and in H_2SO_4 it has six, gaining 2. Therefore 2 mols. HNO_3 are needed for the reaction.

For thorough training in the principles of oxidation the author advises the student to prepare a number of compounds with pure ingredients, determining the exact proportions to be used according to the system laid down. The body of the work, the analytical portion, requires little comment. The directions given, as far as we have been able to perceive, are accurate and well arranged, and the work is enriched with useful tables.

Trade Report of Gehe and Co., Dresden. September, 1880.

THIS report gives as usual very full and accurate information concerning the prices of drugs and chemicals and their probable value in the immediate future. It is remarked that, with few exceptions, the aniline colours are still declining in price. The dyes most in demand are:—Fast Scarlet G G N, Phosphine N and R M, Magenta S, Methyl Violet 5B and 6B, and Methyl Green A, Eosine W, and V3 are more generally employed since the reduction in price. Considerable attention is being drawn to the milky juice of *Carica papaya*, which, however, appears difficult to collect in quantity.

CORRESPONDENCE.

THE SPECIFIC ROTATORY POWER OF CANE- AND INVERT-SUGAR.

To the Editor of the Chemical News.

SIR,—In a letter (CHEMICAL NEWS, vol. xlii., page 196) referring to my paper on the above subject, Mr. Alexander Watt questions my statement that "many authorities appear to have assumed that a solution of inverted sugar contained the same percentage of sugar as before inversion." In support of his scepticism Mr. Watt adduces the fact that

such an error would cause the adoption of too high a number for the specific rotatory power instead of one below the truth.

In proof of my statement that some authorities have really ignored the increase of weight by inversion I may refer your correspondent to "Watts's Dictionary of Chemistry," vol. v., p. 472. He will find it distinctly involved in the calculations given, that a solution of cane-sugar which originally had a rotatory power of + 73·8 degrees will after inversion rotate 25° to the left.*

In the new edition of "Miller's Chemistry," Part III., Section I., edited by H. E. Armstrong and C. E. Groves, a similar error occurs on page 605. Taking the values +57·6 and −106 as the specific rotations of dextrose and levulose respectively, the editors derive −24·2° as the value of *aj* at 14° C. for invert sugar. So far, all is right; but they go on to say—"The number of degrees of lævo-rotation produced by a solution of the invert-sugar formed from a solution of cane-sugar of known dextro-rotatory power, is calculated by multiplying the number of degrees of dextro-rotation exhibited by the cane-sugar solution by 0·32, since the specific rotatory of cane-sugar is $[a]j = 73·8°$ and $24·2 = 73·8 \times 0·32$." Here the increase of weight by inversion is again distinctly ignored.† With the correction the factor would be 0·3455, a figure which differs considerably from the correct one, 0·37.

The above instances are sufficient to establish my statement that the increase of weight by inversion had not unfrequently been overlooked. I by no means intended to intimate that the error had invariably occurred. On reading my paper in print I noted some obscurity in the wording, and regretted that absence from home had prevented me from correcting the proof before publication.

I am indebted to Mr. Watt for pointing out the true origin of the value −25°, hitherto universally adopted as the specific rotatory power of invert-sugar. As this calculated value is dependent on an erroneous number for dextrose and a doubtful one for levulose it is quite time it became obsolete. As stated in my paper, the true value of $[a]j$ for levulose is most probably −109·6 at 14° C., instead of −106°, as commonly stated.

While writing on the subject of specific rotation, I may call attention to the confusion caused by chemists not distinctly stating the degree of hydration of the substances operated on. Crystallised dextro-glucose contains 1 atom of water, and apparently the low results of some observers are due to the employment of the imperfectly dehydrated sample. Similarly, a recent determination of the specific rotation of milk-sugar by Mills and Hogarth is deprived of much of its value by the omission of the authors to indicate the condition of hydration of the sample.—I am, &c.,

ALFRED H. ALLEN.

Sheffield, October 16, 1880.

* By a curious misprint the value +25° is in one equation printed "+27." As the sum of 27+73·8 is twice stated to be 98·8 it is clear that the 27 is really a typographical error.

† This is the more curious, as on page 609 of the same work the same error is not made.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 7, August 16, 1880.

Polar Electricity in Hemihedral Crystals with Inclined Surfaces.—MM. Jacques and Pierre Curie.—All the facts observed hitherto agree in showing that in all the non-conductive substances with inclined surfaces which have been examined there is the same connection between the position of the hemihedral facettes and the direction of the phenomenon of polar electricity. The physical signification of the above will be better understood by saying more colloquially, but more tersely, that the more pointed extremity of the hemihedral form corresponds to the positive pole by contraction, whilst the more obtuse extremity corresponds to the negative pole.—M. P. Thenard remarked that the same phenomenon had been observed by his son fifteen years ago.

New Results of the Utilisation of Solar Heat obtained at Paris.—M. A. Pifre.—The author's improved apparatus enables him to utilise 80 per cent of the solar heat, thus obtaining, at Paris, 12·12 cal. per minute and per square metre of surface exposed to the sun.

Production of Crystals of Chromium Sesquichloride of a Persistent Green Colour.—M. A. Mengeot.—The author allows hydrochloric acid to act upon potassium bichromate dissolved in water. If the solution is allowed to evaporate for about ten months the bottom of the vessel is found lined with deep violet crystals of chromium sesquichloride, but among these large violet crystals are some small green crystals of a salt of chromium. According to all authorities the green salts are only formed at 100°; they are not crystalline, and they gradually pass into the violet condition. But the production of these green crystals takes place at common temperatures, and they have remained green for more than two years.

No. 8, August 23, 1880.

Remarkable Instance of Lightning Ascending Vertically.—A. Trécul.—The author perceived during the storm of the evening of August 19th, lightning ascending perpendicularly behind the trees of the Place Jussieu, apparently from the conductors of the wine magazine.

The Sun has a Sensible Inductive Action on the Earth, even when its Magnetic Power is simply equal to that of our Globe. Induction of the Moon by the Earth and Diurnal Lunar Variation of the Terrestrial Compass.—M. Quet.—The sun induces the earth in various manners; by its rotation, by the speed of the earth in its orbit, by the rotation of the earth, and by the variations which it experiences in its electric constitution. The electromotive forces due to the three first-mentioned causes are:—The first 14 times greater than the second, and the second 72 times greater than the third.

The Variations of the Coefficient of Expansion of Glass.—J. M. Crafts.—In his former papers the author has summed up the most important theories on the variation of the fixed points of thermometers, but the variation of the coefficient of expansion of glass, which presents a much more serious inconvenience, has hitherto escaped notice. If this coefficient varies, the interval between two fixed points varies, and the graduation becomes inexact. In thermometers, heated for a long time to 355°, the coefficient of expansion decreases, so that whilst the zero-point is raised by t degrees, the point 100° is raised to $100° + t + l$.

Tungstoboric Acid.—D. Klein.—This acid differs in its constitution from various other borotungstic acids which have been prepared, and is the analogue of the unknown decatungstic acid. It is formed by the union of 9 mols. tungstic acid, 1 mol. dimetaboric hydrate, with elimination of 6 mols. water. Its composition is—

$$9WO_3, Bo_2O_3, 4H_2O.$$

Products of the Distillation of Colophonium.—Ad. Renard.—The author has isolated a carbide, which he names heptene, of the sp. gr. 0·8031 at +20. It is without action upon polarised light, and boils at 103° to 106°. He examines its behaviour with reagents.

No. 9, August 30, 1880.

Dilatation and the Compressibility of Gases under Strong Pressures.—E. H. Amagat.—The author concludes from his researches that the coefficient of expansion

of gases for temperatures above the critical temperature increases with pressure up to a maximum, on passing which it decreases indefinitely. The maximum diminishes for the more elevated temperatures, and finally disappears. For pressures lower than the critical pressure the deviation, which is at first positive at a temperature sufficiently low, becomes null, and then negative as the temperature increases; but, proceeding from a certain negative value, it diminishes indefinitely without changing its sign. For the pressures comprised between the critical pressure and a superior limit, special for each gas, the period during which the deviation is positive is preceded by a period where it is negative, so that the deviation changes its sign twice.

The Amylamines of Inactive Amylic Alcohol.—R. P. Plimpton.—A description of a diamylamine and a triamylamine, both inactive.

Intensity of Certain Phenomena of Atmospheric Electricity Observed in the North of the Sahara.—L. Amat.—In tropical countries the electric phenomena of the atmospheric stratum in contact with the soil are more distinct than in colder climates.

No. 10, September 6, 1880.

Researches on Basic Salts and on Atacamite.—M. Berthelot.—The author considers that in this compound, $CuCl,3CuO,4HO$, the water serves as the chief connecting link. A metallic salt may be completely precipitated and the resulting liquid neutralised without an equivalence between the precipitating alkali and the acid of the metallic salt, a portion of the latter being carried down in the precipitate. A great number of metallic salts behave in an analogous manner.

Contribution to the History of the Ethers.—M. Berthelot.—The transformation of the simple ethers into alcohols corresponds in a state of solution to a thermic phenomenon, which is almost *nil*.

The Law of Electro-magnetic Machines.—J. Joubert.—A mathematical paper, not susceptible of useful abridgment.

The Variations of the Fixed Points of Mercurial Thermometers, and the Means of Recognising them in the Determination of Temperatures.—J. Pernet.—The author agrees with M. Crafts that the part played by pressure in the permanent elevation of the zero-point is very trifling, if it exists at all.

Boro-deci-tungstic Acid and its Sodium Salts.—D. Klein.—If tungstic acid in excess is dissolved in a boiling solution of borax with twice its molecular weight of boric acid (crystalline), the ebullition kept up for some hours, the undissolved tungstic hydrate filtered off the resulting solution deposits crystals of boric acid and sodium polyborates. The mother-liquor, if concentrated and placed in a vacuum, deposits first borax and then the exceedingly soluble sodium salt of the new acid, containing 2 mols. of constitutional water.

Chemisches Central-blatt.

No. 18, 1880.

Appearance of Ozone on the Evaporation of Various Liquids as a Lecture Experiment.—R. Böttger.—The author recommends to moisten a piece of paper uniformly with starch containing cadmium iodide, to let fall upon it a few drops of alcohol or ether, and to set the latter liquid on fire. After its evaporation the paper is found turned decidedly blue in consequence of the formation of ozone.—*Pol. Notizblatt*, 35, 95.

Singular Behaviour of Stannous Chloride with Potassium Chlorate. — R. Böttger. — If 2 parts of stannous chloride and 1 part potassium chlorate, both previously pulverised, are rubbed together in a porcelain morter, the mixture becomes very hot, chlorous acid and watery vapour are evolved, and there remains a yellowish white mass, which, if dissolved in boiling water, deposits potassium perchlorate in micaceous crystals. The mother-liquor contains tin oxychloride.

Action of Nitric Oxide upon Organic Bodies.—E. Lippmann and R. Lange.—A preliminary notice.—*Wien. Anzeiger*, 1880, 48.

No. 19, 1880.

On Idryl.—G. Goldschmiedt.—The author describes a number of derivatives of this hydrocarbon.—*Wien. Anzeiger*, 1880, 56.

Hypochlorine and the Conditions of its Origin in Plants.—M. Pringsheim.—The author has previously demonstrated the existence of a body in the green cells of plants, which he named hypochlorine on account of its relation to chlorophyll. He describes in this paper its occurrence and its micro-chemical characters.

No. 20, 1880.

Chlorides of Camphor.—F. V. Spitzer.—The products which arise on the action of phosphorus pentachloride upon camphor are affected by the quantity of the phosphorus chloride present and by the temperature. If every increase of temperature is prevented no hydrochloric acid appears, and there is formed a homogeneous camphor dichloride in theoretical quantities. Pfaundler's dichloride and the body melting at 60° and described as monochloride, are probably merely mixtures.—*Wien. Anzeiger*, 1880, 71.

Chemical Investigations in the Bohemian Central Mountains.—J. Stoklasa.—An examination of the marls and clays of Priesen.—*Listy Chem.*, 4, 135.

Böddcker's Method of Detecting Albumen in Urine.—R. Böttger.—The urine is slightly acidified with acetic acid, and a few drops of a solution of potassium ferrocyanide are added. In presence of even very slight traces of albumen a turbidity at once appears, and in a short time there is deposited a flocculent sediment. The author considers the test exceedingly sensitive.

No. 21, 1880.

Decomposition of Simple Organic Compounds by Zinc-dust.—Hans Jahn.—The higher alcohols from ethylic alcohol upwards, on distillation over zinc-powder which was heated to 330° to 350°, were decomposed into the corresponding olefine and hydrogen. Under the same circumstances methylic alcohol is resolved into carbonic oxide and hydrogen.—*Wiener Anzeiger*, 1880, 73-74.

New Synthesis of Dimethyl-acrylic Acid. — E. Duvillier.—This compound is formed along with ethyl-isoxy-valerianic acid when brom-iso-valerianic ether is brought in contact with sodium ethylate in absolute alcohol.—*Ann. Chim. Phys.*, 19, 429.

Chloraluminium used at Cloth Works.—F. Stolba.—A sample contained 15·49 per cent Al_2Cl_6, 1·13 Al_2O_3, 2·59 NaCl, 0·14 Na_2SO_4, 80·65 H_2O. Apparently formed by decomposing aluminium sulphate with barium chloride.—*Listy Chem.*, 4, 193.

No. 22, 1880.

True Clay in so-called Clay Soils.—A. Funaro.—The highest proportion of clay does not exceed 33 per cent.

Physico-Chemical Analyses of Soils.—M. Pellegrini.—The author compared the methods of Schlœsing, Nœbel, and Masure, and obtained such differences as clay, 37 and 87; sand, 1·5 to 28. He considers Schlœsing's method the most satisfactory.

No. 23, 1880.

Crystalline Prussian Blue.—W. Gintl.—If recently-precipitated Prussian blue is treated with a moderate excess of hydrochloric acid at a gentle heat, it dissolves to a slightly yellowish liquid, which, on exposure to the air, gradually deposits Prussian blue as a crystalline sediment, which displays a splendid coppery lustre by reflected light. So-called Turnbull's blue dissolves in hydrochloric acid in the same manner as ordinary Prussian blue, and

yields similar crystals,—a further evidence for the identity of the two compounds.

Synthesis of Chinoline.—Z. H. Skraup.—The alizarin blue of Prud'homme has the composition $C_{17}H_9NO_4$, and is probably a dihydroxylised quinon of anthrachinoline. It is formed from nitro-alizarin and glycerin, with the elimination of water. Chinoline is actually obtained on heating together nitro-benzol, glycerin, and sulphuric acid. *Wiener Anzeiger*, 1880, 69.

Function of Lime in the Life of Plants.—E. v. Raumer and Ch. Kellermann.—Lime is absolutely necessary for the life of plants, and its function is most closely connected with the utilisation of the carbohydrates.

Crystals of Hæmine.—F. Högyes.—The author has examined crystals from the blood of men, oxen, swine, sheep, dogs, cats, rabbits, guinea-pigs, mice, pole cats, poultry, pigeons, geese, ducks, *Rana esculenta* and *temporaria*. All have one only crystalline form. They belong to the monoclinar or triclinar system, probably the former.

Journal de Pharmacie et de Chimie.
May, 1880.

The Curare of the Upper Amazon.—G. Planchon.—This memoir is rather of a botanical than a chemical nature.

Commercial Sub-nitrates of Bismuth.—A. Riche.—The author points out great variability in the composition of this body.

The Alkalies of the Cinchona.—E. Jungfleisch.—Already noticed.

The Spectroscope Applied to the Chemical and Pharmaceutical Sciences.—M. Coulier.—An essay on the selection of a spectroscope and on its use in analysis.

Virulent Maladies.—M. Pasteur.—Already noticed.

Electrolysis of Malonic Acid.—E. Bourgoin.—Already noticed.

Decompositions of Copper Acetates in Presence of Water, under Influence of a High Temperature.—P. Cazeneuve.—Already noticed.

Apiculture at Paris.—In some of the suburbs of Paris vast numbers of bees are kept which subsist by plundering the sugar refineries.

June, 1880.

Curare of the Upper Amazon.—G. Planchon.—A continuation from the last number.

Composition of Officinal Sodium Arseniate.—J. Lefort.—The composition of this salt varies very considerably, especially as regards its proportion of water.

Thapsia garganica.—L. Soubeiran.—A botanical-pharmaceutical paper.

Electrolysis of the Malonates.—E. Bourgoin.—A continuation from the last number.

Method of Determining the Fatty Acids Contained in Oils.—M. Carpentin.—The author takes a small flat-bottomed flask or a medicine phial holding about 250 c.c. Into this phial are measured 50 c.c. of the sample of oil, and 100 c.c. of alcohol at 90 per cent, and 3 or 4 drops of tincture of turmeric are added. The phial is then corked and violently shaken. The phial is then placed under a Mohr's burette containing a solution of 40 grms. pure sodium hydrate per litre of water. As 40 grms. soda saturate 282 of oleic acid, 1 c.c. of the liquid, containing 0·04 grm. soda, corresponds to 0·282 grm. of oleic acid. If another fatty acid has to be determined this number is modified accordingly. The alkaline liquid is carefully dropped into the phial, which is shaken. When a red colouration appears it is corked, agitated for a considerable time till the yellow colour reappears, the alcohol having extracted a fresh quantity of acid out of the oil. These operations are continued until the red colour becomes permanent. The number of c.c. and the fraction of a c.c. consumed are then multiplied by 0·282 grm., in order to find the quantity of oleic acid present in the sample examined.

New Apparatus for Determining the Total Nitrogen in Organic Matters in General and in Urines in Particular.—M. Flavart.—The author substitutes for the glass combustion tube an apparatus of copper, which does not require so complete a desiccation of the soda-lime.

MISCELLANEOUS.

Testimonial to Prof. Attfield, F.R.S.—At the recent meeting of the British Pharmaceutical Conference the above-named gentleman resigned the position of Senior Honorary Secretary, which he has held for seventeen years. As a mark of their appreciation of his services he was presented by members of the Conference with five hundred volumes of general literature, along with a scroll, setting forth the origin of the testimonial, and bearing the signatures of the President, Prof. Redwood, F. B. Benger, and other leading officials and members.

COMPOSITION AND QUALITY OF THE METROPOLITAN WATERS.

August, 1880.

	Total Solid Matter.	Oxygen required by Organic Matter, &c.	Nitrogen as Nitrates, &c.	Ammonia.	Hardness. Clark's Scale. Before Boiling.	Hardness. Clark's Scale. After Boiling.
	Grs.	Grs.	Grs.	Grs	Degrees.	Degrees.
Thames Water Companies.						
Grand Junction	18·72	0·072	0·142	0·000	14·3	2·4
West Middlesex	20·76	0·080	0·125	0·000	14·3	2·0
Southwark and Vauxhall	18·39	0·060	0·125	0·000	14·3	2·4
Chelsea	18·82	0·120	0·125	0·000	14·3	2·6
Lambeth	19·72	0·080	0·125	0·000	14·0	2·8
Other Companies.						
Kent	30·17	0·000	0·410	0·000	21·2	5·2
New River	20·14	0·028	0·142	0·000	14·8	2·4
East London	20·25	0·036	0·137	0·000	15·4	2·8

(The results are stated in grains per imperial gallon of 70,000 grains.)

Note.—The amount of oxygen required to oxidise the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours.

The water was found to be clear and nearly colourless in all cases.

C. Meymott Tidy, M.B.

TO CORRESPONDENTS.

V. T. Magerstein's Researches.—The journal in which V. T. Magerstein's researches appear, the *Listy Chem.*, is written in the Czech language, and published in Prague. We quote it through the medium of the *Chemisches Centralblatt*.

THE JOURNAL OF SCIENCE

for OCTOBER (Price 1s. 6d.), includes—

The Vehicle of Force. By Charles Morris.
Exploration in the Far East.
The Phenomena of Fluorescence. By E. R. Hodges.
Gilbert White Reconsidered.
The Four Forces in Nature. By G. Whewell, F.I.C.

Analyses of Books. Correspondence. Notes.

London: 3, Horse-Shoe Court, Ludgate Hill.

In the High Court of Justice, Chancery Division.—In the Matter of the Companies Acts, 1862 and 1867, and in the Matter of the Patent Liquid Metallic Capsuling Paint, Gilding, and Silvering Company (Limited).

MESSRS. FRANK LEWIS and CO., will SELL by AUCTION, by order of the Official Liquidator, on the Premises of Mr. S. J. Jerrard, Ennersdale Street, Lewisham, on Wednesday next, October 27, at 12 o'clock, the STOCK-IN-TRADE and UTENSILS of the above Company, comprising about 600 gallons collodion, ether, and other spirit, 16 carboys nitric and sulphuric acid, about 200 lbs. gold, silver, and bronze powders, aniline colours, drugs, two galvanising tanks, large quantity of stoppered bottles, glass retorts, evaporating pans, also an iron safe, copying press, partitioning, and other effects.—May be viewed the day before sale and catalogues had on the premises; of F. Romer, Esq., Solicitor, No. 13, Warwick Court, Gray's Inn; of George Sneath, Esq. (Messrs. Price, Waterhouse, and Co., Accountants), No. 44, Gresham Street; the Official Liquidator; and of Messrs. Frank Lewis and Co., Auctioneers, &c., 95, Gresham Street, E.C.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities for persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

MR. J. S. MERRY,

ASSAYER AND ANALYTICAL CHEMIST,

SWANSEA.

ROYAL POLYTECHNIC.—Asmodeus, the Bottle Imp. Ventriloquism and Magic, by Professor Hellis. Modern and Machine Guns, the New Forest, the Oxy-hydrogen Microscope, &c., by Mr. J. L. King. Musical Entertainment by the talented Adison family. Sights of London, by Mr. Heath. Blondin and Leotard, the marvellous Automata. Diving Bell, Moving Machinery and Models. The Royal Polytechnic Barometer, &c. Stokes on Memory, Tuesdays and Thursdays at 7. Open 12 till and 7 till 10. Admission 1s.

MOTTERSHEAD & CO.,

7, Exchange Street and 10, Half Moon Street,

MANCHESTER.

CHEMICAL & PHYSICAL APPARATUS,

BOTTLES, PURE CHEMICALS,

REAGENTS, STANDARD SOLUTIONS,

And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

GREENBANK ALKALI WORKS COMPANY (LIMITED),

ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{3}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

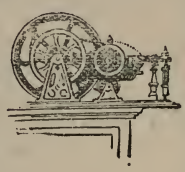
CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

Carr's Patent Paint and Drug Mill.

Approved by some of the most eminent Chemists, and awarded the Silver Prize Medals of the Manchester and Liverpool, and the Middleton Agricultural Shows.



From Messrs. E. H. SMYTH & Co., 21, Duke Street, Edinburgh, and 69, Coleman Street, City, London.—The small Levigator Mill we recently got from you works most efficiently, and is a great economiser of time.

The chief feature in this machine is, that although it can be turned with ease by a boy, it has immense frictional power for levigating purposes. This is caused by the runner being driven at a much greater speed, but in the same direction, than the bowl. The surfaces being Minton ware, they are clean, smooth, and durable.

Testimonials on application.

£11 nett cash, delivered in Manchester.

The diameter of the bowl is 18 ins., and it and the runners are made of Minton ware. It is useful for Painters, Chemists, Grocers, and Cooks, for triturating and mixing Medicines, Vegetable Powders, Ointments, Paints, Sugar, Salt, Spices, Herbs, Meat for Potting, and will grind the COARSEST EMERY INTO A NEARLY IMPALPABLE POWDER in a few seconds. The pan can be tilted for emptying, as shown in the dotted lines; it can be worked by hand or power.

SOLE MAKERS—
W. H. BAILEY & Co., Albion Works, Salford, Manchester.

BISULPHIDE OF CARBON,

CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,
161, 162, 163, PALMERSTON BUILDINGS, LONDON, E.C.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

THE CHEMICAL NEWS.

Vol. XLII. No. 1092.

THE EFFECTS OF MAGNESIA ON VEGETATION.*

By MAJOR-GENERAL SCOTT, C.B., F.R.S.

Not among the least wonderful of the anomalies in the conduct of human beings is the persistence, in opposition often to their own interests, with which they adhere to a prejudice long after it has been overturned by experience. The erroneous views of the effects of magnesia on vegetation affords a notable instance. Eminent cultivators have given their testimony from actual practice of its favourable effects, yet the prejudice continues so strong that farmers will often carry other limes from a long distance, and at a much greater cost, rather than employ those made from dolomite. Its slower absorption of carbonic acid, or some defect in the mode of using it, had given in the first instance an unfavourable impression regarding magnesian lime, and this impression has been handed down from one author to another, and has been accepted by the unthinking agriculturist without question. Instances occur, even, in which men of science have contributed to the propagation of the error.

Now and again there has been some slight protest against the assumption that magnesian lime had qualities noxious to vegetation, but these protests have produced little effect, and the substance, though known to be an important constituent of plants, has seldom been made a component of manures. Thus, Prof. Johnston, in 1849, recommended the making of experiments both with caustic and mild or carbonate of magnesia, and stated that "In consequence of previous recommendations it (carbonate of magnesia) has been tried in numerous experiments by Mr. Gardner, at Barochan, in Renfrewshire, and by Mr. Main, at Whitehill, in Midlothian. This was never applied alone by these gentlemen, but always as an ingredient of mixed manures, in which it formed only a small proportion. These experiments therefore throw no light upon the special effects of this substance on our different crops and soils."

Thirty years after this we find Mr. Jamieson thus writing in the Report of the Proceedings of the Aberdeenshire Agricultural Association for 1878. Speaking of the essential ingredients of plants, he says that they "may benefit or injure plants according to the combination in which they are applied; thus chloride of lime and carbonate of magnesia are said to be plant poisons, although composed of ingredients which are beneficial in other forms, such as carbonate of lime, sulphate of magnesia, chloride of potash, &c." And again—"As to magnesia, it may be put down quite as a neglected substance in manures. Judging from examination of soils, its application is called for in many cases more urgently than most of the other essential ingredients."

It is true, also, that Messrs. Lawes and Gilbert introduced 16·3 per cent of sulphate of magnesia (=2 per cent of magnesia) into the mixed mineral manures employed in their experiments at Rothamstead, and small quantities were used in the trials of manures made in 1841 and 1842 in Scotland; but one of the most eminent authorities on the question of manures, M. Ville, whose work has been justly received with much appreciation by agriculturists in America and England as well as in his own country, does not think it necessary to introduce magnesia into manures at all, not because he does not consider it to be an essential element in vegetation, but because, as he states, "it is found in the soil naturally," and of course he means in sufficient abundance for the requirements of plants. How far the accuracy of this opinion is borne out by the facts he cites is, I think, open to question, and I therefore place the whole matter, almost in his own words, before you, and it will form an appropriate introduction to my paper.

M. Ville gives in his work the analysis, by Davy, of six samples of earth from different sources, "all renowned for their fertility," and states that all six possess the same degree of fertility. Now, Sir Humphry Davy, in his work on "Agricultural Chemistry," gives the analysis of three of them, and of these he says one was from a hop-garden, another from a "good turnip soil," and a third from "an excellent wheat soil." In none of the six samples, excepting that from the "hop-garden," did Sir Humphry Davy find any magnesia, and in that he found 0·7 per cent of magnesic carbonate (=0·33 magnesia). M. Ville gives also the analysis of a soil from Chalons-sur-Marne, by M. Rivot, which showed only traces of magnesia. At the same time they contained, with one exception (which had only 0·6 per cent of calcic carbonate), a fair proportion of lime, viz., from 4·7 to 57·2 of calcic carbonate. It is true that in the days of Davy methods of analysis were not so accurate as at present, and that magnesia might have been, and most probably was, present in some of the five samples in which it was not detected or noted by him, but the magnesic element must have been present in insignificant proportion in comparison with the calcic.

At the end of his work M. Ville gives tables for calculating the relative exhaustion of soils under different crops, but in these tables no mention whatever is made of magesia as an element abstracted from the soil by plants, though it is an undoubted fact that the seeds of peas, beans, rape, and wheat carry off a comparatively large proportion of it. In 100 parts of the seed crop of wheat there are 12 parts of magnesia and only 4 of lime, and in the straw of this plant the quantity of magnesia is about one-half that of the lime; yet M. Ville omits magnesia from his normal manure for cereals, though lime, in the somewhat soluble condition of sulphate, forms nearly one-half of the whole compound recommended for a wheat crop, and these facts appear the more remarkable when we examine the experiments made with the different mineral elements of plants by M. Ville. With reference to these experiments he says:—"This time a fixed and invariable quantity of nitrogenous matter was mixed with the [calcined] sand [soaked with distilled water] as a constant ingredient, and all the other mineral ingredients were added by turns except one. The experiments were repeated as many times as there were different mineral ingredients, in order that each might be excluded in its turn, the deviation between the crops obtained with the ten mineral ingredients and those in which they were reduced to nine being taken to indicate the degree of importance of the suppressed ingredients." . . .

"Magnesia was submitted to the same method of exclusion. The defects were as disastrous as in the case of potash."

"There are some plants, particularly buck-wheat, on which the effects of this suppression are immediate, on wheat they are manifested a little more slowly, but are still very significant, and when magnesia is excluded from the soil the yield falls to about 123 grains instead of 337." . . . .

"The suppression of the lime produces a less sensible effect, the yield is then about 307 instead of 337." . . .

"Leaving the culture in calcined sand, I extended my investigations to various natural soils.

"On submitting them to the same experimental system we found that . . . the yield is maintained at the same level as when sulphur, silica, soda, magnesia, iron, and chlorine are added, which explains to you why I did not go further into the effects of those bodies. Experience therefore shows that the four ingredients—nitrogenous matter, phosphate, potash, and lime—are the only ones that need be admitted into manures (Ville, p. 153-5).

* A paper read before the Chemical Section of the British Association, Swansea Meeting, 1880.

"I give the name, therefore, of normal manure to the mixture of phosphate of lime, potash, lime, and a nitrogenous material.

"In so doing I do not intend to deny the utility of the other ingredients; I exclude them from the manure because the soil is provided with them naturally." . . . .

"If we pass from these fundamental data to the function of each mineral ingredient in particular, the results are neither less expressive nor less explicit. The soil being provided with nitrogenous matter as a constant ingredient:—

	Wght. of Crop.
With all the mineral matter except phosphate, *nil*	grains
" " " " potash,	138 "
" " " " magnesia,	107 "
" " " " sol. silica,	123 "
" " " " without any suppression,	275—237 grns."

(P. 156—157.)

M. Ville's conclusions respecting magnesia, and indeed silica, appear to me to be far from convincing. If the above results can be said to demonstrate anything, they demonstrate that magnesia comes next to phosphate in importance as an element of mineral manures, and, as I shall show eventually, this is not far from the truth. I shall, however, now proceed to show that there are experiments recorded indicating that considerable advantage is derived by adding to very many soils more magnesia than they naturally contain, and we shall find, also, important testimony to its value where it naturally occurs.

Sir Humphry Davy, in opposing the notion of the noxious qualities of magnesian lime, and accounting for this prevalent and erroneous opinion, states that—

"Magnesia in its mild state—*i.e.*, fully combined with carbonic acid, seems to me to be always a useful constituent of soils. I have thrown carbonate of magnesia upon grass, and upon growing wheat and barley, so as to render the surface white, but the vegetation was not injured in the slighest degree; and one of the most fertile parts of Cornwall, The Lizard, is a district in which the soil contains mild magnesian earth. The Lizard Downs have a short and green grass which feeds sheep, producing excellent mutton, and the cultivated parts are amongst the best of corn lands in the country." (Davy's "Agricultural Chemistry," pp. 299-300.)

Davy also found that wheat grew better in a soil with which he had mixed peat and magnesia than in either the "pure soil," or the pure soil and peat alone. It grew very well in the "pure soil," and nearly as well as with magnesia in the mixture of peat and pure soil, but peat often contains a notable quantity of magnesia. The ashes of the brown herbaceous peat in the neighbourhood of Troyes contain 14 per cent of magnesia, and those of a peat from the frontiers of Bavaria and Bohemia contain 3·5 per cent of it. Gelatinous silica and sulphate of lime are also frequent constituents of peat, and the fact, therefore, that the mixture of peat and pure soil gave better results than the pure soil, derogates little, if at all, from the evidence of improvement given by magnesia. Again, Morton, in in his "Encyclopedia of Agriculture" in opposing the erroneous opinions current against the use of magnesian lime, mentions that—"In the neighbourhood of Castellamonte and Baldissiro, the most luxuriant vegetation is met with in a soil which contains a very large quantity of magnesia, and in our own country many very fertile soils are found in the new red sandstone formation, which likewise is rich in magnesia."

John Donaldson, the author of a "Treatise on Manures," having been engaged in the cultivation of land in the immediate neighbourhood of Breedon magnesian rock, in Leicestershire, says:—"I had occasion to use considerable quantities of lime, and consequently had a fair opportunity of proving the quality of that rock for agricultural purposes." On two fields (the farm, he tells us, had been most miserably scoured and impoverished by the preceding tenants) he spread the magnesian lime at the rate of 200 bushels an acre, and in another field "a double allowance of lime, or 400 bushels, per acre . . . which, being both a large quantity and in a caustic state, would test the supposed noxious quality of the lime. In every case the green crops were good . . . one field was sown with barley, which yielded a most beautiful crop of 7½ quarters per acre, and the other produced 5 quarters of wheat; both very great crops when the exhausted state of the land was considered."

"When the wheat braided in November, the space which had got 400 bushels to an acre immediately showed a great superiority, which continued to the day of reaping, being much thicker on the ground, of a darker colour throughout the winter, and afforded more produce as the shocks were thicker in the ground, and discernible in the first view of the field. The succeeding crop of hay on that space showed an equal superiority, and for several years in succession."

"The same lime was used in the same quantity, of 200 bushels to an acre, and with the same beneficial results, without a single exception. On the headland, where the lime lay and where any damage might have been expected, there grew a very close and heavy crop of beet, with roots not equalled in size and weight. Many eminent cultivators join in the same opinion of magnesian lime derived from actual practice."—"A Treatise of Manures," by J. Donaldson, pp. 157-8.

This experiment is very instructive and conclusive, for on comparing the results obtained with the constituents of each of the various crops it will be observed that the beneficial results were in proportion to that of the magnesia which the ash contains. Though the green crops were good it is specially mentioned by Donaldson that the space which had the double allowance of magnesian lime, "*showed no difference on the turnip crop.*"

The following table, extracted from "How Crops Grow" (Eng. Ed. by Church and Dyer), gives the percentage of magnesia and lime in the ashes of the crops alluded to:—

	Magnesia.	Lime.
Turnips (mean of 3 sorts) ..	2·9	11·2
Hay	4·9	11·6
Barley—straw	2·4	7·6
" seeds	8·3	2·5
Beet	8·9	6·3
Wheat—straw	2·6	6·2
" seeds	12·2	3·1

We here see that Donaldson's results are exactly in accord with what would have been predicted from a consideration of the mineral constituents of the different crops. The turnip, containing the smallest proportion of magnesia, is not benefitted by the presence in the soil of a double proportion of that substance, probably the 200 bushels to the acre of Breedon lime supplied quite enough lime and more magnesia than was necessary for that crop; but in the case of wheat, where for the formation of the seed a very large supply of magnesia was necessary, the dose of 200 bushels to the acre was insufficient to enable the roots to find the requisite amount of magnesia for the full development of the crop, and yet, if, in this matter, we are to follow M. Ville's prescription, the soil naturally contains enough magnesia to supply all the wants of wheat, though analysis shows the presence of mere traces of it only, or none at all. Mr. N. Whiteley, Land Surveyor, the author of a treatise on "The Application of Geology to Agriculture," whilst receiving as well founded the common prejudice against the magnesian lime in its hot state, does full justice to the fertilising effects of magnesia in its mild condition. He says, speaking of land near St. Kevern, in Cornwall:—If we seek for a soil theoretically perfect it may be found in this formation. The large amount of magnesia which this fruitful soil contains (9 per cent) is worthy of observation." Of the magnesian limestone formation he says that "much of it is thin, light, and dry," and "we are prepared, there-

fore, to meet with a soil of medium quality. Much of the soil on the magnesian limestone is in arable culture, but from Standrop to Darlington the soil may be considered the best and richest grazing land in the north." Strong confirmation of the views I am seeking to establish, is to be derived from a consideration of the cases of soils, which are either abundantly supplied with, or are very deficient in magnesia.

In the following table are given the proportions of lime and magnesia found in both fertile and barren soils. I give the lime as well as the magnesia, because that substance is considered, very rightly, a most important ingredient of manures, although usually its proportion in soils is considerably in excess of the magnesia.

Proportion of Lime and Magnesia in 1000 *parts of very Fertile and Fertile Soils.*

	Exceptionally Fertile.					Fertile.			
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Lime ..	26·0	9·3	12·6	61·5	12·29	42·1	12·9	7·4	5·3	5·6
Magnesia	9·5	11·6	8·8	8·8	10·82	6·1	5·7	5·3	4·9	3·1

No. 1. Is from the analysis of the celebrated black earth of Russia. This remarkable soil is "the finest in Russia, whether for the production of wheat or grass." It nourishes, on 60,000 square geographical miles, a population of more that 20 millions of souls, and yet "exports upwards of 50 millions of bushels annually." This very properly stands first in my table as it contains a very large amount of magnesia, and is the most fertile probably of any which the table includes.

No. 2. From an analysis by Sprengel of the soil of Nebstein, near Olmutz, in Bavaria, which had been cropped in 1847 for nearly 160 years successively, "without either manure or naked fallow."

No. 3. By Boussingault: a soil from Calvario, near Tacunga, Ecuador, S. America. It "possesses extraordinary fertility."

No. 4. "A very fertile alluvial soil from Honigpolder," analysed by Sprengel; no manure has ever been applied to it. The sub-soil contains to a great depth the same composition as the surface soil.

No. 5. Soil from Midlothian, analysed by Dr. Anderson. It "produces excellent wheat."

No. 6. From an analysis by Sprengel of a very fertile alluvial soil in East Friesland, formerly overflowed, but which had been, in 1863, cultivated for 60 years with corn and pulse crops *without manure*.

Nos. 7, 8, 9, 10. From soils at Göttingen, from near Hanover, from Alt-Arenberg in Belgium, and from a virgin soil on the banks of the Ohio, respectively. The analyses are by Sprengel.

I do not of course assume that the fertility of these soils is due entirely or chiefly to the magnesia they contain (the black earth of Russia, for instance, contains also more than 2 per cent of nitrogen), nor do I suppose that in very many cases the addition of magnesia, where the proportion of it is less, cannot be dispensed with, but I do say, seeing the disastrous effects which accompany its absence, as shown by Ville, the question merits the serious attention of agriculturists. This will be more apparent from the following table of—

Barren Soils, showing the Proportion of Lime and Magnesia in 1000 *parts of Soil.*

	11.	12.	13.	14.	15.
Lime ..	0·96	0·01	traces	2·9	3·2
Magnesia	traces	traces	0·12	0·7	1·3

No. 11. Refers to a soil which Dr. Sendtner characterises as the most sterile soil in Bavaria.

Nos. 12 and 13. Soils from the neighbourhood of Friesland; also barren.

No. 14. A very barren soil from Luneberg. This soil is wanting in many other elements besides magnesia, and is probably too rich in iron.

No. 15. Also from Luneberg, analysed by Sprengel, as also was the case with the three preceding numbers.

Here again I deprecate the supposition that I hold the barrenness of these soils to be solely, or even principally, due to the absence or scarcity of magnesia. Many of the other constituents of plants, not considered by Ville as essential to a manure, are also wanting, as well as some that he deemed to be indispensable.

Probably the opinion of Dr. Liebig may carry with it more weight with the generality of persons, than any of the foregoing evidence in favour of making a more extended use of magnesia in manures. In his "Natural Laws of Husbandry (pp. 257-8) he says, with reference to guano, the best probably of manures now in the market:—

"If we compare the composition of the ashes of various seeds we at once see that the incombustible constituents of guano do not altogether replace the soil constantly carried off in the seeds.

"In 100 parts of seed-ash are contained:—

	Wheat.	Peas and Beans.	Rape.
Potash..	30	40	24
Lime	4	6	10
Magnesia	12	6	10
Phosphoric acid..	45	36	36

"Whereas guano ash contains in each 100 parts:—

Potash	1·56 to 2·03
Lime	34·00 to 37·00
Magnesia	2·56 to 2·00
Phosphoric acid	41·00 to 40·00

"The principal difference between the ash of guano and that of those seeds lies in the deficiency of potash and magnesia in the former. Agriculturists are generally agreed about the necessity of potash for vegetation, and that a supply is required by fields poor in that ingredient, or drained of it; but the question as to the importance of magnesia for seed formation has not as yet met with the same attention, and special experiments in this direction would be very desirable.

"The fact that much more magnesia is found in the seeds than in the straw unmistakably shows that it must play a definite part in the formation of the seed, which might, perhaps, be ascertained by a careful examination of seeds of the same variety of plants containing different amounts of magnesia. It is a well-known fact that the seeds of the several species of cereals, having the same proportion of nitrogen, do not always contain the same nitrogenous compounds, and it is possible that the nature of the latter, may, in the formation of the seeds, be essentially influenced by the presence of lime or of magnesia, so that the difference in the proportion of both of these alkaline earths may have a certain connection with the presence of the soluble nitrogenous compounds (albumen and casein), or of the insoluble gluten or vegetable fibrine."

To pursue this subject further in the direction indicated by Liebig is a task for which I feel myself unequal, but it encourages me to examine narrowly the records of experiments in magnesia has been made an element of manures, or has been tried alone, or in conjunction with an acid. Of experiments made with magnesia alone I know of no further instances of a definite and reliable kind than those of Donaldson, above quoted, but concerning experiments with sulphate of magnesia both alone and combined with other constituents, there are records to which I can refer for further proof of my argument. Before doing so, however, I wish to call attention to a fact which has a considerable bearing on the case. Both Liebig and Ville hold that farm-yard manure, excellent manure as it is, must be supplemented with mineral substances, if full value is to be given to it, and that additional phosphoric acid is necessary to make all of its nitrogen available for plant life. Now in 100 parts of farm-yard manure there is less than 0·14 per cent of magnesia, and of its mineral constituents the magnesia forms only 1·7 per cent. Donaldson tells us "the quality of earthy compost and of farm-yard

manure is prodigiously improved by a mixture of seaweed. During the seasons of the seaweed coming on shore the farmers have heaps of dung or soil in readiness to receive the immediate benefit of the wrack; and these heaps, along with any lands which may be in a state fit to receive it, afford a ready application of this invaluable article. Farm-yard manure for turnips is improved by it almost beyond description . . and never fails to vindicate the expectations of its effects." (Donaldson, p. 123).

Now, what are the components of the ash in seaweed? No less than from 7 to 20½ per cent of magnesia are found in different kinds of it, and the ashes of the seaweed at the mouth of the Mersey contain upwards of 15 per cent. No doubt in the growth of the turnip crops the advantage is largely derived from the great amount of potash the seaweed contains, but of this substance the ash of dung itself yields upwards of 9 per cent, whereas it yields only, as stated, 1·7 per cent of magnesia. In the ash of dung, therefore,—

$$\frac{\text{potash}}{\text{magnesia}} = \frac{5\frac{1}{3}}{1};$$

in that of the turnip—

$$\frac{\text{potash}}{\text{magnesia}} = \frac{8}{1};$$

In seaweed—

$$\frac{\text{potash}}{\text{magnesia}} = \frac{2\frac{1}{2}}{1}.$$

It is reasonable, therefore, to suppose that the turnip if manured with seaweed as well as dung, derives more of the benefit from the magnesia added by the seaweed than from the potash thus supplied.

We will now proceed to examine some of the experiments made in 1842 and reported by Professor Johnston, which have been already briefly referred to.

Results of experiments with sulphate of magnesia:—

1. "On Yellow Turnips," by Mr. McLean Braidwood, Midlothian, 1842.

Farm-yard manure 30 carts produced per acre 24 tons	
Do. with ½ cwt. of sulphate of magnesia mixed with it ..	25 ,,

Or the increase gained by ½ cwt. of sulphate of magnesia was 4 per cent.

2. "On Yellow Turnips," by Mr. Fleming, Barochan, Renfrewshire, 1842. Variety, "Early Liverpool."

Nothing 1st plot	11·40
,, 2nd ,, ...	12·85
Sulphate of magnesia, 1 cwt.	14·85

Here 1 cwt. of sulphate of magnesia alone gives an increase of upwards of from 12 to 30 per cent (mean 21 p.c.), but as the sulphate of magnesia was not tried in duplicate less reliance can be placed on this experiment.

3. "On Potatoes," variety Early American, carried out by Mr. Fleming, Barochan, in 1842.

Intended to test the comparative advantage of sulphate of magnesia when applied as a top dressing to the young plant, and when mixed with the manure at the time of its application.

As Top Dressing.

No.	Description of Manure.	Quantity of Manure per Acre.	Produced in Tons per Acre.
1.	Nothing but dung ..	40 c. yards	12·75
2.	Sulphate of magnesia	1½ cwts.	13·25
3.	Sulphate of soda ..	2 ,,	12·75
4.	Nitrate of soda.. ..	1½ ,,	16·00
5.	Nitrate of soda.. .. / Sulphate of magnesia	1 ,, / 1 ,,	22·50

Manure mixed with Dung at time of Planting.

6.	Farm-yard dung alone	35 c. yards	8·75
7.	Sulphate of magnesia	2 cwts.	11·35
8.	Sulphate of soda ..	2 ,,	8·00

These results are very interesting. It might be supposed that the increase in the crop was due to the sulphuric acid and not to the magnesia, but inasmuch as sulphate of soda gave no advantage, the effect is plainly not due to the sulphuric acid, unless we suppose the soda to have been injurious, which is not likely to have been the case with turnips and potatoes. An increase of sulphate of magnesia appears also to improve the crop; when 1½ cwt. of the salt was used, as a top dressing, with the dung, the increase was only 4 p. c.; but when 2 cwts. were used with the dung at the time of planting the increase was close upon 30 per cent. The result of this experiment appears, moreover, to confirm the view that the mixture of the ashes of seaweed and dung derives no unimportant advantage from the quantity of magnesia thus introduced into the plant.

4. "On Clover and Rye Grass cut for Hay," by Mr McLean Braidwood, Midlothian, 1842.

Nothing	125	stones per acre
Sulphate of magnesia, 1½ cwts...	290	,, ,,
Gypsum 3 ,, ..	200	,, ,,

Here the use of 1½ cwts. of sulphate of magnesia gave the enormous increase of upwards of 130 per cent, whilst 3 cwts. of gypsum (sulphate of lime) gave an increase of 60 per cent only. It will be of interest at this point to refer to the composition of the mineral constituents of the turnip, potato, clover, and hay as respects the proportions in them of lime and magnesia, for we shall then see that the advantage gained by the crops experimented on has been in general accordance with what might have been expected from the components of their ashes. I have given also the percentage of sulphuric acid for reasons stated below.

Percentage of Sulphuric Acid, Lime, and Magnesia in the Ashes of—

	Sulphuric Acid.	Lime.	Magnesia.
Turnips—the bulbs	13·60	13·60	5·34
,, entire plants ..	12·52	23·27	3·09
Potatoes—tubers	13·65	2·09	6·28
,, entire plants ..	12·52	13·11	5·55
Clover	3·33	32·80	8·40
Rye grass hay	3·25	6·50	4·01
,, seed	3·24	19·24	5·51

The entire plants of the turnip and potatoe require in the ash 3·09 p.c. and 5.55 p.c. of magnesia, and clover and rye grass crops (taken in the average proportion of the ashes of their respective crops, viz., 400 lbs. to 220 lbs. per acre) require 7·3 per cent of that substance. The advantage gained by the use of sulphate of magnesia as shown by these experiments was—

	Per cent.	Magnesia in ash being—
For turnips	15⅓	3·09 (mean)
,, potatoes..	30	5·55
,, clover and rye grass	130	7·30

If this coincidence is accidental it is extraordinary Another point to which I wish to call attention is the fact that the advantage gained is manifestly largely due to the magnesia and not to the sulphuric acid only; for, where the advantage was the greatest by far, the sulphate of lime did not produce an equivalent effect, though the 3 cwts. of calcic manure carried to the soil upwards of six times the amount of sulphuric acid that the 1½ cwts. of the magnesic salt supplied; and though the latter is far more soluble than the former, gypsum is sufficiently soluble for all the requirements of plants.

A third point remains for remark, and that is the relative effect produced on potatoes in the above experiments of Mr. Fleming, of Barochan, by the use of dung, No. 1; of sulphate of magnesia, No. 2; of sulphate of soda, No. 3; of nitrate of soda, No. 4; and by the use of a mixture of nitrate of soda and sulphate of magnesia, No. 5. A comparison of these results can leave little doubt in the mind

of the immense value of magnesia as an ingredient of a manure for potatoes. By the addition of 2 cwts. of sulphate of soda to the dung no advantage was gained; when 1½ cwts. of nitrate of soda were added to the dung the extra supply of nitrogen in its nitric acid increased the produce 30 per cent; but when 1 cwt. of sulphate of magnesia was added to the dung, together with 1 cwt. only of nitrate of soda, the amount of produce rose upwards of 76 per cent upon what was given by dung alone. Moreover, it is quite clear that as the 1½ cwts. of nitrate of soda alone gave an increase of only 30 per cent, and when sulphate of magnesia was added to the manure, the nitrate at the same time being reduced by 50 per cent, the produce rose to 76 per cent, more than one-half of the advantage was probably due to the sulphate of magnesia. I have before shown, and my conclusions are confirmed by these experiments, that the benefit is chiefly attributable to the magnesia, and not to the sulphuric acid combined with it. There is, indeed, one other possible supposition at variance with this conclusion, viz., that the 1½ cwts. of nitrate of soda was too large a quantity to use per acre, but all experience contradicts this idea.

The following are the results recorded by Prof. Johnston of the experiments on cereals as far as they affect our investigation. The quantities of manure and the crops are per acre—

With barley, common white—

		Bushels of Grain.
Nothing	3400 lbs. of straw and	47·25
1½ cwts. sulphate of soda ½ ,, ,, magnesia	3928 ,, ,, ,,	54·90

With oats, 2nd crop, after old lea, the manure applied as top dressing two months after sowing—

Nothing	2896 lbs. of straw and	54·00
16 cwts. rape dust	2592 ,, ,, ,,	44·96
1 cwt. sulphate of soda..	2792 ,, ,, ,,	38·56

With spring wheat after turnip—

Nothing	4056 lbs. of straw and	47·65
16 cwts. rape dust	4600 ,, ,, ,,	51·05
1 cwt. sulphate of soda..	3864 ,, ,, ,,	38·00

With winter wheat as top dressing—

Nothing	2560 lbs. of straw and	24·93
84 lbs. sulphate of magnesia .. .. 5 cwts. rape dust	3200 ,, ,, ,,	28·40

As the above crops were not the same and the quantities of manure employed differed, and were applied at different times, no exact results may be deducible from the above trials, but as the experiments were all with cereals we are able to draw general conclusions from them which are not unimportant as to the effects of magnesia as a manure, and

First.—As sulphate of soda when used alone proved in each case prejudicial, we may assume that at least it did not materially assist the result when mixed with sulphate of magnesia.

Second.—As rape dust when used alone gave only a certain increase to the crop, any further increase when used with sulphate of magnesia must be due to the influence of the latter substance, and

Third.—As rape dust used alone with oats *decreased* the crop of grain 16·6 per cent, and with spring wheat only increased the grain by 7 per cent, whereas when used in conjunction with 84 lbs. only per acre of sulphate of magnesia (=13·6 lbs. of magnesia), as a top dressing with winter wheat, the increase rose to nearly 16 per cent, it is reasonable to suppose that some portion, indeed a considerable portion, was due to the influence of the sulphate of magnesia, small as it was, and not to the rape dust as a single agent. So far as the rape dust improved the result it may be supposed to be attributable to the influence of the magnesia, to which substance Liebig, as we have seen, assigns a very definite part in the formation of the seed.

It must be borne in mind, in considering the question how far a soil is likely to be improved by an increase of the amount of magnesia in it, that crops remove from the soil the greater portion of their mineral constituents within a short space of time as compared with the whole duration of the existence of the plants, and that, therefore, it must be of the greatest moment that they should be able to gather them from the soil within this period. After a certain time a cultivated plant advances little in size and weight, although great changes occur in the distribution of its constituents.

Liebig says, with manifest truth:—"As a soil may contain far more potash or magnesia or lime than the crop may require, yet being diffused through a large quantity of earth, the roots may be unable to collect the ingredients fast enough to supply the growing wants of the plant. To such a soil it will be necessary to add a further portion of what the crop requires."

The last experiments to which I shall refer are those of Dr. Pincus, of Insterburg, which Liebig characterises as most important, both on account of the careful manner in which they were conducted and the conclusions drawn from them. Three plots of ground were selected lying close together, each of about ⅛ of an acre in extent, from the middle of a large clover field. The clover crop had a very promising appearance, and the plants were then about one inch high; one of the plots was manured with 1 cwt. of gypsum, the second with the same quantity of sulphate of magnesia, and the intervening plot was left unmanured. When all were in flower the clover was mown, and the following were the results:—

	Per ⅛ acre.
Without manure	21·6 cwts.
With gypsum (sulphate of lime).. ..	30·6 ,,
With sulphate of magnesia..	32·4 ,,

Or the gain with the use of the magnesic salt as a manure was just 50 per cent. It is to be observed that the stems were developed by both the sulphates much more than the leaves and flowers. The experiment also showed that there was no proportion between the quantities of sulphuric acid found in the crops and in those supplied by the two sulphates. The quantity of sulphuric acid severally in the two sulphates was 31·12 lbs. in the sulphate of magnesia and 44·18 in the sulphate of lime, which is about 6 : 8·8. The quantities of sulphuric acid in the crops obtained severally by sulphate of lime and sulphate of magnesia were as 6 : 8, and on the plot manured with sulphate of magnesia, which had received less sulphuric acid than the gypsum plot, the amount of vegetable matter was 8 per cent higher than on the latter.

Liebig from experiments made on arable soils came to the conclusion that dressing a field with sulphate of lime makes the magnesia in the soil soluble and distributable. An experiment made to test this conclusion showed that the contact of arable earth with the solution of sulphate of lime is attended by an actual substitution of magnesia for lime. If this notion be correct it points to a cheaper mode of supplying magnesia to the soil than to add sulphate of magnesia to manures, for it follows that the use of gypsum in conjunction with comparatively small doses of magnesian lime will effect all that is necessary in cases in which heavy carriage interferes with the use of an abundant supply of that substance.

In conclusion, though any one of the above proofs of the value and importance of magnesia in a manure may not carry conviction with it, yet, taken altogether, the evidences are overwhelming against the notion that soil naturally contains so much magnesia that an extra supply will be of little or no benefit. Moreover, there are strong grounds for supposing, as we have already indicated, that magnesia, like phosphoric acid, is not only an essential ingredient of plants and aids in their nutriment, but that it determines also the beneficial action of the other ingredients.

DETERMINATION OF THE FREE OXYGEN DISSOLVED IN WATER.

By J. KŒNIG and C. KRAUCH.

THE authors, after referring to the researches of F. Tiemann and C. Preusse (*Ber. der Deutsch. Chem. Gesell.* for 1879, p. 1768), whose results they have not been able to confirm, enter upon an examination of the methods of Bunsen, of Mohr, and of Schützenberger and Risler. Their experiments lead to the following conclusions:—Reichardt's apparatus is not suitable for a quantitative determination of the gases in liquids. The circumstance that even when the access of air from without is cut off more air is still found than agrees with Bunsen's coefficients of absorption, and that a determination of the proportion of air dissolved in water effected with the apparatus of Jacobsen and Behrens yields more air, seems to point out that the absorption-coefficients of air for water, as calculated by Bunsen, are not valid under all conditions.

Mohr's method of determining oxygen in water yields invariably too high results—a conclusion exactly opposite to the one of Tiemann and Preusse. On what this difference depends the authors are not able to explain. If, however, Mohr's method is always exactly followed, it yields numbers which are relatively accurate, or, in other words, which are comparable among themselves. Waters which have been exposed to direct sunshine or to daylight yield more oxygen by Mohr's method as compared with the other two methods than the water of deep wells which has been for a considerable time excluded from sunlight.

Schützenberger's method yields results which fall below the truth. For absolutely accurate determinations of the oxygen in water neither Mohr's method not that of Schützenberger is suitable, the results of the former being too high and those of the latter too low. Where merely relative accuracy is required—as, *e.g.*, in the examination of well-waters—both methods may be used with equally good results. Mohr's method is suitable when single determinations have to be made at regular intervals, because the standard solutions required are more permanent and can be kept for a considerable time without change. Schützenberger's method is suitable when a great number of determinations of oxygen have to be made in succession in a very short time. The value of the sodium hydrosulphite solution should be determined for this purpose, not by means of a copper or iron solution, but by means of water containing a known quantity of dissolved oxygen.—*Zeitschrift fur Analytische Chemie.*

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

PHYSICAL AND MATHEMATICAL SECTION.

Annual Meeting, April 27, 1880.

E. W. BINNEY, F.R.S., F.G.S., President of the Section, in the Chair.

THE following gentlemen were elected Officers of the Section for the ensuing year:—

President—E. W. Binney, F.R.S., F.G.S.

Vice-Presidents—Joseph Baxendell, F.R.A.S., Alfred Brothers, F.R.A.S.

Treasurer—James Bottomley, D.Sc., B.A.

Secretary—Rev. Thomas Mackereth, F.R.A.S., F.M.S.

"*Colorimetry, Part V. (On the Absorption of Light by Turbid Solutions)*," by JAMES BOTTOMLEY, D.Sc.

Media containing colouring matter may be divided into two classes, transparent and turbid. It might be considered that in their behaviour with regard to light they were wholly dissimilar. But the question arises, is not the difference between transparency and turbidity one of degree. Experience in the laboratory brings under our notice cases where matter is so finely divided as not to be separable from fluids by filtration, and showing but slight tendency to settle as a precipitate, and in some cases we have liquids which are apparently transparent, and yet are considered to hold solid matter in suspension. May not such examples be intermediate between solutions and cases where extremely fine particles are uniformly diffused through some transparent medium? If, then, we consider the passage from transparency to turbidity as a continuous one, and if for a transparent fluid we have established some law of absorption of light, may not the same law be applicable to a turbid solution? The subject seemed to me interesting both as a scientific enquiry and on account of its application to quantitative analysis.

Suppose we have diffused through a liquid some finely divided solid matter; the action of such a turbid solution on light will be twofold—it disperses light and it absorbs light. By reason of the first action we are made aware of the colour of the turbidity; by reason of the second, any object seen through the liquid seems of diminished distinctness.

As a typical case, take carbon diffused through water. In a paper which I read at the last meeting of the Physical and Mathematical Section I alluded to some attempts to obtain a soluble black, in order to make some experiments on the absorption of light. To assist my judgment as to the appearance which such a liquid should present, I had a cylinder containing a little carbon diffused through water. Weak diffusions of carbon in the colorimeter gave the same appearance when I looked at external white surfaces as I should have expected a liquid containing a soluble black in solution to give under the same conditions. A diffusion of carbon both disperses light and absorbs light. The dispersion gives rise to a greyish tint, due to the light coming from the innumerable particles of carbon. Owing to the absorption a white surface seen through the column of liquid seems of diminished whiteness. Hence, under ordinary circumstances, the light which comes to the eye has a twofold origin, part being transmitted light and part dispersed light. My first object was to dissociate these two phenomena. I therefore used cylinders which were covered with black cloth, admitting light by circular apertures at the bottom, 8 m.m. in diameter. In this way the dispersed light was almost wholly cut off. In some cases a feebly nebulous light could be seen round the apertures, but it was very slight, and did not interfere with experiments to determine the absorptive properties. With any attempt to explain by physical optics the analogy of the absorption of light by solutions and diffusions I have nothing to do, but on the supposition that there was continuity, I was led to expect that a function of the same form would express the intensity of the transmitted light in both cases. Also, independently of such considerations, it seemed probable from a reflection upon the mode of distribution or the particles throughout the mass of fluid, that the function would be the same as for transparent solutions. In the latter case, both experiment and reasoning from first principles concur in giving a formula $\Sigma\alpha\kappa$ for the intensity of light passing through a column t units long. As I have pointed out in another paper, this implies an expression of the form $\Sigma\alpha\kappa Q$ denoting the connection between the transmitted light and the quantity of colouring matter. Therefore, we might expect a similar expression to hold in the case of diffusions (the term seems to me more convenient than to speak of turbid solutions). If such be the case, one consequence will be that, if we have two cylinders containing in equal bulks of water Q and Q' of solid matter in suspension, if we adjust the columns so as to obtain the same intensity of light when we regard external white surface, then the lengths of the columns will fulfil the condition $Qt = Q't'$.

The carbon that I used was lamp-black re-calcined in a covered platinum crucible. After being so treated it

seemed blacker than it did before. Of this 0·4170 grm. was ground up in a mortar with 10 drops of a solution of gum. The contents of the mortar were then rinsed out with water, and diffused by shaking through 500 c.c. of water. This was poured into a cylinder; the length of the column was 22·5 c.m. After the lapse of twenty-four hours I drew off by a pipette the upper portion; the column so removed was 15·8 c.m. long. This carbon diffusion contained so much solid matter that I found it inconveniently strong for experiments, so as occasion required I made weaker diffusions, containing in 250 c.c. 5, 10, 20, or 40 of the stronger diffusion. Of these weaker liquids portions were taken and mixed with water so as to yield a bulk of 500 c.c. I stated above that the carbon was ground up with 10 drops of gum, so as to yield a smooth thick consistence. The amount of dry gum would be very small, nevertheless it had a remarkable effect in increasing the adhesion of the carbon to the water. When I had shaken up carbon alone with water it had sensibly subsided after the lapse of a few hours. After the addition of so small a quantity of gum the tendency to deposit is much diminished. The following are the details of some experiments. The strength of the carbon diffusion is given in terms of the number of c.c. of the strong carbon diffusions in 500 c.c. of water. The external white surface was a sheet of white paper. In all cases I have used the right eye only. The number under A denotes the mean of two trials got by pouring into the cylinder, and therefore likely to yield too low results. B denotes the mean of two trials got by pouring out of the cylinder, and therefore likely to give too high results. C denotes the mean of A and B. D denotes the length required by theory.

Standard diffusion, 1·2 c.c. in 500 c.c. of water, length of column, 21·2.

Expt. I.—Comparison diffusion contains 1·8 c.c. in 500 c.c.

A.	B.	C.	D.
14·35	16·35	15·25	14·13

A second trial gave—

12·65	14·65	13·65	14·13

Expt. II.—Comparison diffusion contains 2·4 c.c. in 500 c.c.

10·6	11·25	10·93	10·6

Expt. III.—Comparison diffusion contains 3·0 c.c. in 500 c.c.

8·4	9·25	8·83	8·48

Expt. IV.—Comparison diffusion contains 3·6 c.c. in 500 c.c.

6·85	7·6	7·22	7·07

Expt. V.—Comparison diffusion contains 4·2 c.c. in 500 c.c.

5·6	6·1	5·85	6·06

Expt. VI.—Comparison diffusion contains 4·8 c.c. in 500 c.c.

5·1	5·55	5·32	5·3

Expt. VII.—Comparison diffusion contains 5·4 c.c. in 500 c.c.

4·1	4·5	4·3	4·71

On another occasion I got a nearer result, as follows:—

4·7	4·95	4·82	4·71

Expt. VIII.—Comparison diffusion contains 6 c.c. in 500 c.c.

4·13	4·58	4·36	4·24

Expt. IX.—Comparison diffusion contains 6·6 c.c. in 500 c.c.

3·98	4·25	4·11	3·85

Expt. X.—Comparison diffusion contains 7·2 c.c. in 500 c.c.

3·48	3·75	3·61	3·53

Expt. XI.—Comparison diffusion contains 7·8 c.c. in 500 c.c.

A.	B.	C.	D.
3·23	3·45	3·34	3·26

Expt. XII.—Comparison diffusion contains 8·4 c.c. in 500 c.c.

3·03	3·45	3·24	3·03

Expt. XIII.—Comparison diffusion contains 9 c.c. in 500 c.c.

2·9	3	2·95	2·82

Expt. XIV.—Comparison diffusion contains 9·6 c.c. in 500 c.c.

2·83	3·05	2·94	2·65

Expt. XV.—Comparison diffusion contains 14·4 c.c. in 500 c.c.

1·98	2·08	2·03	1·77

Expt. XVI.—Comparison diffusion contains 19·2 c.c. in 500 c.c.

1·6	1·58	1·59	1·32

Many of the above numbers are close approximations. I also tried columns of the lengths given by theory in all experiments, except by the ninth, where by an oversight I neglected to do so. The tints so obtained were in every case satisfactory, until I reached Experiment XIV. In this and in the succeeding experiments I thought that columns of the theoretical lengths gave tints slightly lighter than the standard diffusion. On some occasions I have wavered in my opinion that the theoretical column gave too light a tint in the fourteenth experiment. At another time I got the following result:—

Expt. XVII.—Comparison diffusion contains 9·6 c.c. in 500 c.c.

2·8	2·95	2·87	2·65

Here, again, the number under C is a little greater than that under D. I afterwards repeated the experiment with this variation—that the standard diffusion was contained in the comparison cylinder, and the comparison diffusion in the standard cylinder.

Expt. XVIII.—Standard diffusion contains 1·2 c.c. in 500 c.c.; length of column, 22·6.

Comparison diffusion contains 9 6 c.c. in 500 c.c.

2·85	3·07	2·96	2·82

On another occasion I got—

2·85	3·15	3·0	2·82

Here, again, there still remains a tendency to make the column a little longer than the theoretical.

I repeated the experiments in which the strength of the comparison diffusion is several times a multiple of the strength of the standard diffusion. The strength of the standard diffusion was the same as in the previous experiments, and the length of the column was 21·2.

Expt. XIX.—Comparison diffusion contains 9·6 c.c. in 500 c.c.

2·63	2·98	2·8	2·65

When I actually tried the theoretical column I thought that the tint was perhaps slightly lighter.

Expt. XX.—Comparison diffusion contains 14·4 c.c. in 500 c.c.

1·9	2·15	2·02	1·77

The tint given by the theoretical column I thought slightly lighter.

Expt. XXI.—Comparison diffusion contains 19·2 c.c. in 500 c.c.

1·55	1·63	1·59	1·32

The tint given by the theoretical column I thought slightly lighter.

Expt. XXII.—Comparison diffusion contains 24·0 c.c. in 500 c.c.

1·15	1·3	1·22	1·06

The tint given by the theoretical column I thought slightly lighter, but hardly distinguishable.

Expt. XXIII.—Comparison diffusion contains 28·8 c.c. in 500 c.c.

A.	B.	C.	D.
1·0	1·1	1·05	0·88

The tint given by the theoretical column I thought slightly lighter.

Expt. XXIV.—Comparison liquid contains 35·6 c.c. in 500 c.c.

0·88	0·9	0·89	0·76

The tint given by the theoretical column I thought slightly lighter.

Expt. XXV.—Comparison liquid contains 38·4 c.c. in 500 c.c.

0·73	0·83	0·78	0·66

The tint given by the theoretical column I thought slightly lighter; they were, however, very nearly the same.

This second series of experiments confirms the result of the first series that there is a slight departure from the rule, when the strength of one diffusion is several times a multiple of the other. Both series show a tendency to make the column in the comparison cylinder slightly too long. We must not hastily conclude that in these cases the theory is not applicable. It seems to me that we should expect such a result, for the medium is not perfectly transparent, and in one cylinder we have a column of this medium (water) several times a multiple of the length of the column in the other. This would require some slight compensation. In these experiments I have taken the lower level of the meniscus as the proper reading. In some of the stronger diffusions it was a little difficult to determine this exactly. On the whole, I think that the above experiments are favourable to the assumption that for a column of fluid containing finely divided carbon in suspension the relationship Qt=constant holds, if the intensity of the transmitted light remain constant. If we represent the above results graphically, and take as the theoretical curve the rectangular hyperbola $xy=25{\cdot}44$, it will be seen that the results of the experiments do not depart far from the curve.

In a paper read at the last meeting of the section, I suggested a method for testing the assumed laws of the absorption of light. I also have applied the same reasoning and method of experiment to carbon diffusions. In one series of experiments I took a diffusion containing 1·934 c.c. in 500 c.c. The standard shades of grey used were one consisting of 10 grms. $BaSO_4$ and 0·012 of lamp-black—this I denote by Wa—the other consisted of 10 grms. of $BaSO_4$ and 0·048 of lamp-black—this I denote by Wb. The materials were well incorporated by shaking and grinding. To the powder I then added a little water so as to obtain a mixture of suitable consistence to be used as a paint. This was applied by a brush to pieces of cardboard so as to obtain uniform surfaces. These surfaces were then dried, the colorimeters employed were the same as in the last experiments. I looked at Wb through a column 3 c.m. long. I held the other cylinder Wa and endeavoured to get the same tint. The mean of two columns, one probably a little too long, and the other probably a little too short, gave 8·2 as the proper length. So I made the column of this length; I thought that the tints were the same. Now, if the law hold with regard to turbid solutions, if we increase both columns by the same length, the tints will again correspond. I took 4 c.m. as the common increment. The lengths of the columns were made 7 and 12·2; I thought the resulting tints equal. The lengths of the columns were made 11 and 16·2; I thought they were about equal, possibly Wa slightly lighter. My impression varied a little with the illumination of the surfaces. The lengths of the columns were now made 15 and 20·2; the tints seemed about equal, possibly Wa slightly lighter. The difference, if any, must be small, as is shown by the following experiment. Taking Wb, seen through a column 15 c.m. long, as the standard tint, I endeavoured to get the same tint with Wa seen through the other cylinder. For the lower limit I got 19·9 c.m., and for the upper limit 21·0 c.m., the mean of these is 20·45, not far removed from 20·2. Afterwards I thought a column of this length satisfied. I now made the lengths of the columns 19 and 24·2. I thought that the tints again corresponded.

Some experiments of a similar nature were made with a stronger diffusion; it contained 3 747 c.c. in 500 c.c. The tints of grey used were the same as in the last experiments. The standard tint at the commencement was Wb seen through a column 4 c.m. long. To get a similar tint with Wa one determination for the upper limit gave 6·5, and one determination for the lower limit gave 6·1. The mean of these is 6·3. A column of this length seemed to satisfy. The common increment is 3 c.m. The columns were made 7 and 9·3 c.m. long; the tints seemed to correspond. The columns were made 10 and 12·3 c.m. long; the tints again seemed to correspond. The columns were made 13 and 15·3 c.m. long; the tints seemed again to correspond. Finally, the columns were made 16 and 18·3 c.m. long; the tints again corresponded. In the last two experiments the greys obtained were very deep. I also made the following experiment:—I took two grey tints; one consisted of 10 grms. $BaSO_4$ and 0·042 grm. of lamp-black; the other consisted of 10 grms. $BaSO_4$ and 0·4003 grm. of lamp-black. These greys were made into a paint by the addition of a little water, and pieces of cardboard covered with them. They were then dried. These we may denote by $W\alpha$ and $W\beta$. I looked at $W\beta$ through a column 4·1 c.m. long, and endeavoured to get a similar tint with $W\alpha$ under the other cylinder. For the upper limit the column was 6·95 c.m. long, and for the lower limit 6·2 c.m. long; the mean is 6·57 c.m. I next altered the length of the column over $W\beta$ to 11·75. In the other cylinder for the upper limit the column was 14·9 c.m., and for the lower limit 14·8; the mean is 14·85. Hence we have—

$$W\beta K4{\cdot}1 = W\alpha K6{\cdot}57$$
$$W\beta K11{\cdot}75 = W\alpha K14{\cdot}85$$

By cross multiplication and elimination of $W\alpha, W\beta$

$$K4{\cdot}1 K14{\cdot}85 = K6{\cdot}57 K11{\cdot}75$$

Theory requires the sums of the indices to be equal.

The sum on the right hand is 18·32, and on the left 18·95. The difference is, I think, not greater than what might be due to errors of observation.

CORRESPONDENCE.

A NEW HYDROGEN COMPOUND. (?)

To the Editor of the Chemical News.

Sir,—Having lately seen some interesting researches into the nature of hydrates conducted by Lt.-Col. W. A. Ross by means of the blowpipe, I venture to suppose these, and the way they are done, will be of equal interest to a numerous circle of readers.

It need hardly be mentioned that the investigation of the ultimate composition of hydrates is, from the very circumstances of the case, impossible by the ordinary solution processes of chemistry. An assay is needed. But, though slowly, the blowpipe method of analysis is forming its own separate chapters in the best works on chemical science, and deservedly. Great improvements have been made on the system of Plattner, and many are due to Col. Ross himself, whose two books, "Pyrology," and a "Manual of Blowpipe Analysis," are the standard England authorities on this branch of analytical chemistry.

The principal of the innovations which give their value to Col. Ross's system are the use of either boric or phosphoric acid as a fluid menstruum, instead of borax, or microcosmic salt; and the employment of an aluminium plate, instead of sticks of messy and obscuring charcoal.

It is at present a very unsettled point how hydrates are composed. Even "Miller's Chemistry" does not solve the whole problem. For instance, there is the case of anhydrous potash. The only theory which explains its production is that when water, symbolised by HHO, comes in contact with potassium K, an atom of hydrogen is displaced by an atom of potassium, the base; and the result is KHO, hydrate of potash. In a similar manner, if the hydrogen be dislodged from the hydrate KHO, we have KKO, anhydrous potash. The inference necessarily is that hydrates are not combinations of water, which is H_2O, and a base; but of a base and a substance, HO, which is still unrecognised. Col. Ross has written about this hypothetical substance under the title of chemical water, having had good grounds for supposing that it, and not sodium, gives the well-known D lines in the spectrum.

However this may be, boric acid is a very suitable vehicle for testing the properties of a lower oxide of hydrogen. In its fused form before the blowpipe, boric acid has the inestimable advantage of being anhydrous. Besides this, boron forms only this single oxide; and, finally, it is transparent, of nearly the same specific gravity as most vitreous masses, and soluble in boiling water.

In advance of the more detailed description which, it is understood, Col. Ross is furnishing to the Royal Society, I may state the process of estimating the oxide of hydrogen of a hydrate as shown me.

Col. Ross takes the purest silica (prepared by Dr. Schuchardt, of Görlitz), heats it to redness, and dissolves an accurately weighed quantity (about 0·037 grain) before the blowpipe, in a bead of pure borate of lime held in a platinum loop. He then notes the weight of the resulting silico-calci-borate bead. The silico-calci-boric bead is next surrounded with free boric acid in a fused state, and treated before the blowpipe. It is observed that the clear boric acid is at once clouded over, which would not be the case with borate of calcium alone, and becomes opalescent and semi-opaque.

The silico-calci-boric bead being, as found by Prof. Stokes, of Cambridge, insoluble, while fused boric acid is soluble, in hot water, is dissolved out and weighed. The result is, notwithstanding the loss of volatile opalescent matter, a very large gain in weight. This process of fusion in excess of boric acid, and subsequent extraction, is repeated four or five times, till there is no further opacity. When the silico-calci-boric bead is ultimately weighed it proves to have increased about 22 per cent.

Col. Ross can only account for the loss by opalescence, combined with an aggregate gain in the weight of the silico-calci-boric bead, on the assumption that the silica parts with the oxide of hydrogen it contains as hydrate, taking up an equivalent of boric acid instead. Hence the opalescence is most likely due to the appearance of HO, which Col. Ross has styled chemical water, and chemists have not yet isolated: the increase of weight to the absorption of boric acid.

But it has also been noticed that after the first exhibition of opalescence the calci-boric bead weighs much more than at the conclusion of the four or five reductions to which it is subjected. The probability, therefore, is that in addition to an oxide of hydrogen, HO, there is a compound of hydrogen and boron; hydroboric acid, in fact, given out in the later stages.

Hydrogen itself is not, according to the latest theory, a simple element, but more correctly a hydride of hydrogenium, symbol HH, these atoms being conjectured to exist in opposite electric states.—I am, &c.,

A. T. Fraser, Maj. R.E.

London, October 25, 1880.

EXPELLING AND COLLECTING GASES IN NATURAL WATERS.

To the Editor of the Chemical News.

Sir,—I beg to call your attention to the fact that the method of expelling and collecting the gases in natural waters described in the Chemical News (vol. xlii., p. 206) is not new. It was proposed by Reichardt (*Ann. f. Anal. Chem.*, vol. xl., p. 271), and is described in detail in Thorpe's "Quantitative Analysis," pp. 324—326.—I am, &c.

C. H. Bothamley.

Leeds, October 25, 1880.

THE SPECIFIC ROTATORY POWER OF CANE- AND INVERT-SUGAR.

To the Editor of the Chemical News.

Sir,—In a reply (Chemical News, xlii., p. 208) to my letter on the above subject, Mr. Allen says that I questioned his statement that "many authorities appear to have assumed that a solution of inverted sugar contained the same percentage as before inversion."

By referring to my letter you will see that the points I doubted were—that any authority should fail to take into account the increase of weight by inversion in calculating the specific rotatory power of invert-sugar, and that the value $-25°$ was erroneous on that account.

In support of his statement Mr. Allen refers me to "Watts's Dictionary of Chemistry" (vol. v., p. 472), and to the new edition of "Miller's Organic Chemistry" (Part 3, Sect. I., p. 605); but as both quotations treat of the estimation of cane-sugar from *given rotatory powers of cane- and invert-sugar*, and *not the determination of* the specific rotatory power of invert-sugar, I cannot accept them as proofs of his original statement.

As I have already shown the origin of the value $-25°$ given in "Watts's Dictionary," and as Mr. Allen's quotation from "Miller's Organic Chemistry" shows that the value $-24·2$ is also a *calculated and not an observed* value, it is evident that these numbers cannot be regarded as the result of assuming "that a solution of inverted sugar contained the same percentage as before inversion.—I am, &c.,

Alexander Watt.

Liverpool, October 26, 1880

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 11, September 13, 1880.

Certain Solar Phenomena observed at Nice.—L. Thollon.—This paper cannot be usefully abstracted without the accompanying figures.

Law of Electro-magnetic Machines.—J. Joubert.—The author concludes that the retardation is equal to one-eighth of the entire period. The intensity is constant and equal to the quotient by V_2 of the absolute maximum of intensity. The electro-magnetic work is proportional to the speed. The speed is in a constant ratio to the resistance.

Boro-duo-deci-tungstic Acid and its Potassium Salts.—D. Klein.—This acid does not lose the last traces of water till near a red heat. It becomes then insoluble, and is decomposed into a mixture of boric and tungstic anhydrides. The new acid is a hydrate of $10WO_3,Bo_2O_3$.

No. 12, September 20, 1880.

Odours of Paris.—Sainte-Claire Deville.—The author, having analysed a portion of the sub-soil taken at about the depth of 1 metre in the Rue Saint Jacques, concludes that the sulphur and the hydrocarbons present are due to the leakage of gas from the mains, to which he ascribes a

sanitary and antiseptic action. He proposes that all excrementitious matter should be received in vessels of metal without ever coming in contact with the external air, and be conveyed away underground in metal pipes, heated to 100° or upwards, dried, and used as manure.

A New Experiment showing the Direction of the Rotation Impressed by Substances upon Polarised Light.—G. Govi.—If a very pure spectrum is produced with light polarised rectilinearly and made to traverse first a plate of rock crystal perpendicular to the axis and then an analyser, the spectrum is furrowed by one or more black bands, which are displaced on turning either the polariser or the analyser. The movement of the bands takes place from the red towards the violet, or from the violet towards the red (the analyser or the polariser being turned always in the same direction), according as the plate of rock crystal is dextro-rotatory or lævo-rotatory. In the direction of this movement we have therefore an indication of the direction of the rotation which the interposed substance impresses on the plane of polarisation.

Study on the Telluric Rays of the Solar Spectrum. L. Thollon.—The author remarks that a complete knowledge of the earth's atmosphere will not be attained until we have an exact and complete knowledge of the telluric rays, the elements which produce them, their variations of intensity according to the temperature, the hygrometric condition of the air, and the height of the sun above the horizon. For this purpose the telluric groups must be resolved into their simple elements, and separated from each other as well as from the other metallic rays; their positions on the spectrometric scale must be determined with all possible exactness; their variations of intensity and the attendant circumstances must be studied, and from these results the original element of each ray must be deduced, and the deduction must be experimentally verified. The author has determined the two first points for Angström's telluric groups, B, D, and α.

Liquefaction of Ozone and its Colour in the Gaseous State.—P. Hautefeuille and J. Chappuis.—Inserted in full.

No. 13, September 27, 1880.

Vapour-tension Manometer for Analysing Liquids and Measuring Pressures.—L. Perrier.—This apparatus does not admit of intelligible description without the accompanying illustration.

The Inventor of Binocular Telescopes.—G. Govi.—This invention appears to be due to D. Chorez, an optician of Paris, who made and sold these instruments in 1625.

No. 14, October 4, 1880.

Utilisation of Chamber Crystals.—C. Girard and A. Pabst.—The authors remark that the use of these crystals in the arts has hitherto been restricted to bleaching silks. They have succeeded in preparing the diazo compounds, amido-azo-benzol, and nitro-alizarin, by causing nitroso-sulphuric acid to act upon the corresponding amido derivatives, or upon aniline and alizarin. They mix the crystals with sodium chloride in a cast-iron apparatus, and the nitrosyl chloride evolved is received into a refrigerated hydrochloric solution of dimethyl-anilin for the preparation of nitroso-dimethyl-anilin. A similar mixture may also be applied to the oxidation and destruction of the gases and vapours given off in the treatment of fœcal matters.

Certain Thermometric Questions.—J. M. Crafts.—The author criticises the paper of M. Pernet (Sept. 6), and raises the question of the fixity of the interval between the points 0° and 100° depending on the permanence of the mean coefficient of expansion of glass between these limits.

Decomposition of Salts by Liquids.—A. Ditte.—The author has previously pointed out (*Comptes Rendus*, lxxix., pp. 915, 956, 1254) that the decomposition of a salt by water takes place according to laws quite analogous to those which govern the dissociation of bodies by the action of heat. These laws are equally applicable to the decomposition of salts by pure water, by saline or acid solutions, by the alcohols. They probably regulate in a general manner the decomposition of salts in the wet way whatever may be the solvent employed.

Journal für Praktische Chemie.
Nos. 11 and 12, 1880.

Combustion-Heat of Organic Compounds.—Dr. C. von Rechenberg.—The author determines the combustion-heat of cane-sugar, tartaric acid, naphthalin, starch, erythrodextrin, inulin, cellulose, gummic acid, maltose, milk-sugar, dextrose, dextrose containing crystalline water, lactose, mannite, dulcite, myristic acid, stearic acid, oxalic, malonic, succinic and citric acids, phenol, anthracen and anthraquinon, and the solution-heat of cane-sugar. Concerning the method employed in Prof. Frankland's researches ("On the Origin of Muscular Power"), he remarks that Stohmann has detected three essential errors: the want of any control as to the complete combustion of the substance employed; too high a production of heat in consequence of the combustion of a part of the copper apparatus, and the impossibility of completely dissolving the potassium chloride formed by the decomposition of the potassium chlorate, whence again an excessive degree of heat is registered.

Process of Saccharification by the Action of Dilute Sulphuric Acid upon Starch at Elevated Temperatures.—Dr. F. Allihn.—The conclusions at which the author arrives are, that the saccharification of starch by means of dilute sulphuric acid proceeds in general the more rapidly and completely the more concentrated the acid, the higher the temperature, and the longer. The quantity of the starch converted is proportional to the time of action up to 40 to 50 per cent. In the later stages the process proceeds more slowly, so that a complete conversion, even if possible under the given circumstances, is reached only after an exceedingly prolonged action. The causes of this retardation lies in the different resistance of the dextrins to dilute acids.

Specific Rotatory Power of Lactose.—Dr. E. Meissel.—The specific rotatory power of pure anhydrous lactose at 17·5° = +88·08.

New Method for the Quantitative Determination of Arsenious Acid in the Presence of Arsenic Acid.—Leopold Mayer.—Taking as a point of departure the known property of arsenious acid to reduce ammoniacal solutions of silver at a boiling heat, the author bases upon it a convenient gravimetric method for the determination of arsenious acid along with arsenic acid. The common method of precipitating arsenic with magnesia solution as ammonio-magnesium arseniate is not free from sources of error, due to the solubility of the latter compound. The methods of H. Rose and Vohl are tedious and circumstantial. The author's method depends upon the following decomposition. If a solution contains in addition to arsenious acid no other substance which reduces the ammoniacal solution of silver at a boiling heat, the reduction takes place according to the following equation:—

$$As_2O_3 + 2Ag_2O = As_2O_5 + 2Ag_2.$$

After boiling for half an hour, the reduced silver separates out as a fine powder and is filtered off and weighed. The quantities of silver thus obtained agree exactly with the arsenious acid employed. The reduced silver must be washed with warm ammonia and water containing sal-ammoniac. If a portion of the silver is reduced in the form of a mirror on the sides of the glass it is dissolved off in nitric acid, precipitated as silver chloride, which is added to the main quantity of the silver for such small traces of silver chloride are reduced on ignition by the carbon of the filter. In applying this method for the determination of arsenious acid in presence of arsenic acid,

the arsenious acid is determined by boiling with ammoniacal solution of silver. On the reduction of the silver, the arsenious acid passes into arsenic acid, which is determined along with the original arsenic acid. The quantity of the latter is found as difference.

Synthesis of Citric Acid.—E. Grimaux and P. Adam.—From the *Comptes Rendus*.

Relpy to W. Hempel on the Salyicylic Acid Question.—E. von Meyer.—A purely controversial paper.

Antimoniferous Manganese Ore.—H. Reinsch.—The author has found antimony sulphide in quantity in the residue from the preparation of chlorine with hydrochloric acid and pyrolusite. The origin of the sample could not be ascertained. (Suppose such manganese ore had been used along with potassium chlorate for generating oygen gas?

Destructive Action of Woody Fibre upon Salicylic Acid—H. Kolbe.—The author points out that the casks in which salicylic acid failed to keep water free from taint were open. As soon, therefore, as the acid was consumed by the wood, septic matter was able to find entrance.

MISCELLANEOUS.

Newcastle Students' Field Club.—We learn with great pleasure that, in order to keep together the students who annually attend the various classes during the winter session, a club is being formed which will, during the summer months, organise Saturday afternoon excursions to localities in the district, "where scientific investigation and research can be combined with social intercourse." The idea is excellent, and if judiciously carried out will not merely keep the students together, but initiate them in the practice of observation in geology, mineralogy, botany, &c. Our informant, the honorary secretary of the new club, does not say with what institution the students in question are connected.

The Graham Medal.—We have much pleasure in drawing attention to the Triennial Medal, instituted by the Chemical Section of the Philosophical Society of Glasgow. It is a handsome gold medal (value about £12), and will be awarded at the end of the present session. The competition is an open one, no restriction whatever being imposed, the committee requiring no more than that the paper shall be original and not a mere compilation. For further information we would draw our readers' attention to our advertisement columns.

MEETINGS FOR THE WEEK.

Monday, Nov. 1st.—Royal Institution, 5. General Monthly Meeting.
Thursday, 4th.—Chemical, 8. "On the Compounds of Vanadium and Sulphur," by E. W. E. Kay. "Report on the Atmospheric Oxidation of Phosphorus, and on some Reactions of Ozone and Peroxide of Hydrogen," by C. T. Kingzett. "Action of Heat on the mixed Vapours of Benzene, Toluene," by Dr. T. Carnelly. "Bismuth and Bismuth Compounds: Part I., Oxides and Hydrates; Part II., Halogen Compounds," by M. M Pattison Muir, G. B. Hoffmeister, and E. E. Robbs. "On the Colour, Properties, and Relation of the Metals Copper, Nickel, Cobalt, Iron, Manganese, and Chromium," by T. Bayley. "Action of Diazo-naphthalin upon Salicylic Acid," by Dr. Percy Frankland. "Action of Organo-Zinc Compounds upon the Nitriles and their Analogues," by Dr. E. Frankland, F.R.S., and C. C. Graham. "Action of Zinc-ethyl on Benzoylic Cyanide," by Dr. E. Frankland and D. A. Louis. "On the Basic Sulphates of Iron," by Spencer Pickering. "Fourth Report on Researches in Chemical Dynamics," Sec. I. by Dr. C. R. A. Wright; Sec. II. and III. Dr. C. R. A. Wright and A. E. Menke. "On some Naphthalin Derivatives," by Dr. Armstrong and N. E. Graham.

THE JOURNAL OF SCIENCE
for NOVEMBER (Price 1s. 6d.), includes—
The Duke of Argyll "On the Unity of Nature." By J. Foulerton, M.D.
Heat and Light. By Robert Ward.
The Baconian Philosophy of Heat. By Dr. Akin.
Mysticism and Asceticism.
The Sanitary Millennium.
Analyses of Books. Correspondence. Notes.
London: 3, Horse-Shoe Court, Ludgate Hill.

Just published (London: J. and A. CHURCHILL), price 16s.
A HANDBOOK OF MODERN CHEMISTRY. By Charles Meymott Tidy, M.B., F.C.S., Professor of Chemistry and of Forensic Medicine at the London Hospital.

PRIVATE LABORATORIES.
THE TRUSTEES of the "YOUNG" CHAIR of TECHNICAL CHEMISTRY having had under consideration the Requirements of INVENTORS, PATENTEES, and others whose investigations require isolation, privacy, and professional advice, have included in the arrangements FIVE PRIVATE LABORATORIES, which, during last session, met a demand hitherto unsupplied in this country.
ALEX. MOORE, Secretary.
128, Hope Street, Glasgow.

BERNERS COLLEGE of CHEMISTRY.
Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.
The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.
Especial facilities or persons preparing for Government and other examinations.
Private Pupils will find every convenience.
Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.
Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

SOUTH LONDON CENTRAL PUBLIC LABORATORY.
A Department has been opened for the Private Instruction of Gentlemen in Practical Chemistry as applied to any Special Industries or Commercial Products they may wish to study. For Fees, &c., apply to W. Baxter, Secretary, Central Public Laboratory, Kennington Cross, S.E.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Aldwick Chemical Works Manchester.

MR. J. S. MERRY,
ASSAYER AND ANALYTICAL CHEMIST,
SWANSEA.

ROYAL POLYTECHNIC.—Asmodeus, the Bottle Imp. Ventriloquism and Magic, by Professor Hellis. Modern and Machine Guns, the New Forest, the Oxy-hydrogen Microscope, &c., by Mr. J. L. King. Musical Entertainment by the talented Adison family. Sights of London, by Mr. Heath. Blondin and Leotard, the marvellous Automata. Diving Bell, Moving Machinery and Models. The Royal Polytechnic Barometer, &c. Stokes on Memory, Tuesdays and Thursdays at 7. Open 12 till and 7 till 10. Admission 1s.

MOTTERSHEAD & CO.,
7, Exchange Street and 10, Half Moon Street,
MANCHESTER.
CHEMICAL & PHYSICAL APPARATUS,
BOTTLES, PURE CHEMICALS,
REAGENTS, STANDARD SOLUTIONS,
And Every Requirement for Works' or School Laboratories or Private Students.
Illustrated Price Lists on application.

BISULPHIDE OF CARBON
PROTOSULPHATE
RED OXIDE
OXYCHLORIDE

Sulphocyanide,

And every other Mercurial Preparation.

BISULPHITE OF LIME, TETRACHLORIDE OF CARBON.

Oxysulphuret of Antimony, Glacial Acetic Acid,

LIQUOR AMMONIÆ,
SULPHIDE OF IRON,
PURE ACIDS,
CHLORIDE OF SULPHUR,
ACETONE,
CHLOROFORM,
ALDEHYDE,
CHLORATE BARYTA,
ARSENIC ACIDS,
FRUIT ESSENCES FOR CONFECTIONERY & LIQUEURS,
PERCHLORIDE OF IRON,
SULPHITE AND HYPOSULPHITE OF SODA,
PHOSPHATES OF SODA AND AMMONIA,
ETHERS,
BROMIDES,
IODIDES,
SCALE AND GRANULAR PREPARATIONS,
SULPHIDE OF SODIUM.

ALSO,

Pure Photographic Chemicals of every kind.

MANUFACTURED BY

WILLIAM BAILEY & SON,

HORSELEY FIELDS CHEMICAL WORKS, WOLVERHAMPTON.

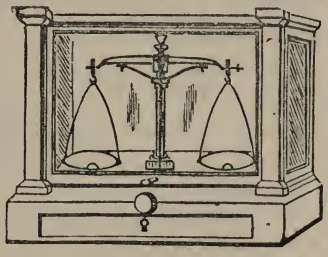
BECKER & SONS,

MANUFACTURERS OF

CHEMICAL AND GOLD ASSAY BALANCES AND OTHER

SCALES AND WEIGHTS.

ROTTERDAM.



NEW YORK.

BECKER'S STUDENT'S BALANCE, in polished mahogany glass case, sliding front, counterpoised, to carry 30 grammes in each pan and turn to ½ milligramme, nickel plated pans £2 10
Ditto, ditto, in mahogany glass case, polished black.. .. .. £2 13

Sole Agents for England, Ireland, and Wales:—

TOWNSON & MERCER.

Becker's Complete Lists forwarded by post on receipt of 1*d.* stamp or free on application.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

THOMAS ADKINS & CO.,
SMETHWICK,
NEAR BIRMINGHAM

MANUFACTURERS OF SPECIALLY PREPARED RED LEAD FOR FLINT-GLASS MAKING.

GREENBANK ALKALI WORKS COMPANY (LIMITED),
ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{3}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

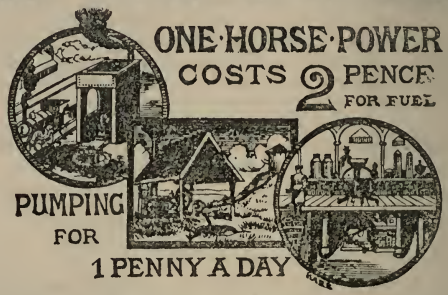
BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

BAILEY'S PATENT HOT-AIR ENGINE.



Made from ¼ to 5 horse-power. 56lbs. of coke will keep a 1-horse going 12 hours. 1000 galls. of water lifted 50 feet high for a penny.

NO BOILER. NO DANGER.

Awarded Prize Medal by the chief Societies.

SOLE MAKERS—
W. H. BAILEY & Co., Albion Works, Salford, Manchester.

BISULPHIDE OF CARBON,
CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,
161, 162, 163, PALMERSTON BUILDINGS, LONDON, E.C.

SILICATE OF SODA, Solid and in Solutions of Various Degrees of Concentration: the finest quality obtainable, and especially adapted for the use of Soap Makers and other Consumers.—JOSEPH CROSFIELD and SONS, Soap Makers, &c., Warrington.

London Agent—H. B. CLARKE, Great Tower Street, E.C.

THE CHEMICAL NEWS.

Vol. XLII. No. 1093.

ON THE ETIOLOGY OF THE CARBUNCULAR DISEASE.*

By L. PASTEUR,
Assisted by Messrs. CHAMBERLAND and ROUX.

One of the diseases which cause the greatest destruction of cattle is the *carbuncular disease*, or *anthrax*. Almost all portions of this country suffer from it; some in a slight degree and others very heavily. The pecuniary loss from this disease is very serious in some localities, as, for instance, in the Department of Eure et Loire. Among the many herds raised there, there is hardly one which is not afflicted by it every year. Any farmer there considers himself fortunate, and even pays no attention to the disease, if his loss is not greater than from 2 to 3 per cent of the number of animals in his flock. This disease is known in all countries. In Russia it is particularly disastrous, and it is called the *Siberian plague*.

For a long time the belief has prevailed that the carbuncular disease is due to various incidental causes, such as the nature of the ground, of the water, of the fodder; the methods of breeding and of feeding. Every cause has been invoked to explain its spontaneous existence. Lately, however, the researches of Messrs. Davaine and Delafond, in France, of Pollender and Branell, in Germany, have called attention to the existence of a microscopical parasite in the blood of animals who have died of this disease. Moreover, rigorous researches have disputed the doctrine of the spontaneous generation of microscopical beings, and the effects of fermentations have been attributed to specific microscopical germs. From these causes, the idea has arisen that possibly animals suffering from carbuncular disease may have acquired its germs, which are the germs of the parasite, from the exterior world, and that there is not, properly speaking, any spontaneous origin to this disease. This opinion became still more definite when, in 1876, Dr. Koch, of Breslau, published that the bacteridia, in its vibrionary or cacillary shape, may be resolved into germ corpuscles or spores.

Two years ago, I had the honour of submitting to the Minister of Agriculture and to the President of the Council General of Eure et Loire, a project of research on the etiology of the carbuncular disease, which was accepted with alacrity. I also had the good fortune to find in M. Manoury, Mayor of the Village of St. Germain, near Chartres, an enlightened agriculturist, who had the kindness to allow me to establish on his farm a small flock of sheep, under the same general conditions that are usual in the Beauce for sheep penned in the open air. Moreover, the Superintendent of Agriculture very obligingly placed at my disposal two shepherd pupils of the School of Rambouillet, to watch and feed the sheep.

The experiments began in the first days of August, 1878. These consisted in feeding certain lots of sheep with lucern, watered with artificial cultivations of the bacteridia of carbuncular disease, containing the parasite and its germs. Without entering into details in this place, I will give the following results of our experiments:—

Notwithstanding the immense number of spores of bacteridia swallowed by all the sheep of one lot, many of them escape death, often after being visibly ill; others, in smaller numbers, die with all the symptoms of spontaneous carbuncular disease, after an incubation, which may extend to eight or even ten days, although towards the last the disease assumes those suddenly violent characters which have led some observers to think that the period of its incubation is very short.

The mortality may be increased in a marked degree by mixing with the food soiled by the germs of the parasite, bodies with sharp points, such as the pointed ends of thistle leaves, and the barbs of oats cut up into fragments about a centimetre in length.

It was important to ascertain if the *post mortem* examination of animals dying in these conditions would shows lesions similar to those which are observed in animals who die spontaneously in sheep folds or in open-air pens. It was found that the lesions in all cases were identical, and the nature of these lesions authorise the belief that the disease begins in the mouth and in the back part of the throat. The first observations of this kind were made in *post mortem* examination, conducted under our own eyes, by M. Boutet and by M. Vinsot, a young veterinary surgeon, and a graduate of the School of Alfort. Both of them have helped us with great zeal during all our experiments in St. Germain.

The idea that sheep which die spontaneously from the carbuncular disease in the Department of Eure et Loire are infected by the spores of the bacteridia of this disease mixed with their food, acquired more consistency in our mind from these examinations. But whence come the germs of these bacteridia? If we reject every theory of the spontaneous generation of this parasite, we must direct our attention to the animals buried under ground.

We must here explain what is done when an animal dies spontaneously from carbuncular disease. If there is an establishment in the neighbourhood for skinning animals, the body is taken there. If no such establishment is in the neighbourhood, or if the hide is of little value, as is the case with sheep, a grave is dug from 0·50 to 1 metre deep and the body is thrown in and covered over with earth. This grave is dug wherever the animal has died, or in some neighbouring field, if he dies in a stable. We may ask: What happens in this grave, and is there in it any cause for disseminating the disease? Many persons will answer in the negative, for Dr. Davaine has ascertained by accurate experiments that an animal who has died of anthrax cannot, after putrefaction, communicate the disease. Very recently numerous experiments have been made by one of the eminent professors of Alfort, a great partisan of the spontaneousness of all diseases. He has reached this conclusion: "That waters charged with the blood of animals who have died of carbuncular disease; that composts made by stratifying earth, sand, and stable manure with remains of bodies of dead sheep brought from Chartres, have never (by inoculation) caused the least symptom of carbuncular disease." (Colin, *Bulletin de l'Académie de Médecine*, 1879). But here we must take into account the difficulties of this research, difficulties of which M. Colin was entirely unaware. To take specimens of earth from the fields of the Beauce, and show in them corpuscles from one to two thousandths of a millimetre in diameter, capable of infecting animals with the carbuncular disease, this is in itself a difficult problem. However, by proper washings, and by making use of the susceptibility of Guinea pigs and rabbits to contract the carbuncular disease, something could be done if the parasites of this disease were the only ones in the earth. But the earth must contain an infinite multitude of microscopical germs of various species, and in the cultivation of these on a living animal, or artificially in vessels they interfere with one another.* During the last twenty years

* Translated from *Comptes Rendus de l'Académie des Sciences* of July 12, 1880, p. 86, by P. Casamajor.

* I am led to believe that in this infinite quantity of germs is to be found the true solution of the nitrification which Messrs. Schlœsing and Müntz have shown to depend on fermentation. One day, if I remember rightly, in July, 1878, I received a visit from these excellent observers. They brought me little pellets from their nitrifying tubes, on which they had not been able to detect microscopic organisms. These, however, were full of germs. I do not believe that any special ferment, any body in the process of development (which would then have a contrary effect) causes nitrification; it is rather a physical effect of absorption and transportation of oxygen on the elements of ammonia by the innumerable germs in the earth, analogous to the influence of *Mycoderma aceti* on alcoholic liquids.

I have often called the attention of this Academy to the struggle for existence between microscopical beings. I may add that to isolate the carbuncular bacteridia from a portion of earth in which it may exist as germs, recourse must be had to special methods, whose application requires the most delicate attention. The action of air, of vacuum, changes in the nature of the media of cultivation, influence of variations of temperature; these are the means which must be used to prevent one germ from hiding the action of another. Any method of research which is not characterised by the most careful attention is powerless, and negative results only prove that, with the conditions in which the observations were made, the bacteridia did not show itself. The main argument presented by the eminent professor of Alfort is that the bacteridia disappears from the body of an animal as soon as it putrifies. This is an accurate statement, and the fact was known by those who flay and cut up the bodies of dead animals long before it was confirmed by Dr. Davaine. I have often heard these men, when handling the dead bodies of horses who had died of anthrax, when I put them on their guard against the danger they were running, say that there is no danger when the body is in an *advanced* state; the danger only exists when it is still warm. Although this fact is not strictly accurate, it agrees very well with what is true. In a previous investigation, published by M. Jaubert and myself, may be found the true explanation of the phenomenon. As soon as the bacteridia in its filiform state is deprived of air, if it is placed, for instance, in vacuo, or in carbonic acid, it resolves itself into granulations of great tenuity which are dead and innocuous. Putrefaction places the bacteridia precisely in these conditions of disaggregation. The germ corpuscles or spores do not go through the same process, as was ascertained by Dr. Koch. At any rate, as the animals at the time of their death only contain the filiform parasite, putrefaction must destroy it entirely. If this opinion was accepted as explaining the facts that take place in nature, we would only have an imperfect idea of the truth.

When a horse, a cow, or a sheep, which has died of the carbuncular disease, is buried in the ground, we may imagine that in most cases some blood finds its way out of the body, even if the animal has not been wounded. A habitual characteristic of this disease is that at the time of death, blood runs out through the nostrils, through the mouth, and even in the urine, which becomes red with blood. Besides, several days must elapse before the bacteridia is resolved into innocuous granulations by the gases free from oxygen which are produced by putrefaction. Meanwhile the excessive swelling of the dead body causes the liquids to run out through the natural openings, and through such ruptures as may exist of the skin and other tissues. The blood and other matters thus mixed with the surrounding portions of aërated earth are no longer in the same conditions as those of putrefaction, but rather in the conditions of artificial cultivation, suitable for the formation of the germs of the bacteridia. Does experiment confirm these preconceived ideas?

We have mixed blood from animals who had died of this disease with earth watered with yeast extract or with urine at the ordinary temperature of summer, and at such temperatures as are maintained by the putrefaction of dead bodies. In less than twenty-four hours, multiplication and production of germ corpuscles of bacteridia have taken place from the bacteridia in the blood. These germ corpuscles may afterwards be found in a condition of latent life, ready to develop, ready to propagate the disease not only after weeks of stay in the earth, but even after years.

But these are only laboratory experiments. We must ascertain what happens in fields exposed to the open air, and to all the alternations of dryness and moisture. In the month of August of 1878, we buried in a garden of the farm of M. Manoury, a sheep of his flock which had died of the carbuncular disease, as verified by a *post mortem* examination. Ten months after this, and also fourteen months afterwards, we took up earth from the grave, and we easily ascertained in this earth the presence of the germ corpuscles of the bacteridia, and, by inoculation on Guinea pigs, we caused their death by the carbuncular disease. Moreover, and this is a circumstance worthy of note, the same investigation was carried on with earth from the surface of the grave, and the germ corpuscles were found to exist, although the earth of the grave had not been disturbed in the interval. Finally, similar experiments were made with earth from graves in the Jura of the depth of two metres, in which had been buried the bodies of cows that had died of this disease in the month of July, 1878. Two years afterwards, which was quite recently, we have collected earth from the surface, and we have obtained deposits from it, which gave rise to the carbuncular disease. Three different times in this interval of two years we have obtained carbuncular disease from this same surface earth. We have finally ascertained that the germs on the suface of graves, in which animals are buried who have died of this disease, may be found after the operations of cultivation and after the gathering of crops. These last experiments were made in several places on the farm of M. Manoury. When these experiments were repeated on earth situated at a considerable distance from the graves, no carbuncular germs have been obtained.

I would not be surprised if, while I am speaking, doubts should rise in your minds concerning the accuracy of these observations. For how can the earth, which acts as a filter so thoroughly, allow microscopical germs to rise to the surface? Such doubts could easily find a justification in the experiments which M. Joubert and I have published. We have announced the fact that water of springs which rise from the earth, even from a moderate depth, are so entirely free from germs that they cannot produce a change in those liquids which are the most easily affected. The waters of springs, nevertheless, rise below portions of the ground through which rain-waters are constantly passing, even during centuries, and their tendency is to carry downwards the finest particles of the earth situated above these springs. There is certainly a great difference between such results and those to which I have called your attention, in which microscopical germs rise from below, even from great depths, in a contrary direction to the flow of rain-water. Here is certainly an enigma. The members of this Academy will certainly be surprised to hear the explanation of it. You may even be astonished that the theory of germs, but lately born from experimental research, has in store such unexpected revelations. Earth works are the carriers of germs, and it is to them that we owe it that the terrible parasite of carbuncular disease is brought to the surface from the depths of the earth, for it is in the little cylindrical agglomerations, and in the finer pellets voided by these worms, and deposited on the surface after heavy dews and after rains that we find the germs of the carbuncular disease, together with with many other germs. We may, by direct experiment, ascertain that it is to this agency that is due the transfer of the germs to the surface. If, in a volume of earth, in which spores of the bacteridia have been mixed throughout the mass, we leave a number of earth-worms for several days, we will, on opening their bodies, so as to carefully extract the earthy cylinders which fill their intestinal canal, find in these a great number of spores of the bacteridia.

If the loose earth at the surface of graves of animals who have died of the carbuncular disease contains the germs of the bacteridia, often in great quantities, they must originate from the disintegration, by rain-water, of the cylindrical excrements of earth-worms. The dust from this disaggregated earth is thrown on plants growing at the level of the ground, and, in this way, animals in the open air find in some pastures the germs of the germs of the carbuncular disease, and become infected exactly in the same way as those in our experiments who fed on Lucern, soiled by artificial cultivation of the bacteridia. These results lead us to meditate on the possible influence

of the soil on the etiology of other disease, on the danger of cemeteries, and the usefulness of cremation!

Do not earth-worms carry to the surface of the ground other germs which may, to the worms themselves, be as harmless as those of the carbuncular disease, but which may be the cause of disease to man and to domestic animals? They are, indeed, constantly filled with germs of all kinds, and in all cases the germs of the carbuncular disease are found associated with those of putrefaction and septicemia.

As to the prevention of the carbuncular disease, it seems easy of accomplishment. Animals must never be buried in fields in which fodder is raised or in which cattle are penned. Whenever such soils can be found, preference should be given, for burying dead animals, to sandy or calcareous soils, in dry situations, as such soils are not favourable to the life of earth-worms. The eminent Chief of Agriculture, M. Tisserand, lately told me that the carbuncular disease is unknown in the region of Savarts, in Champagne. The absence of this disease may be attributed to the fact that in the poor soils of this kind, as in the case of the Camp at Châlons, the thickness of arable land is not greater than 0·15 to 0·20 of a metre, and the subsoil is a bed of chalk in which earth-worms cannot exist. In a soil of this kind, the burying of a carbunculous animal may give rise to many germs, which from the absence of earth-worms will remain at a depth in the ground where they are harmless.

It would be very desirable to have careful statistics stating, in given localities, whether the carbuncular disease is prevalent or not, and also stating the nature of the soil, whether favourable or not to the presence of earth-worms. M. Magne, Member of the Academy of Medicine, has informed me that in the Aveyron, in localities in which the carbuncular disease is found, the soil is argillo-calcareous, while in those in which the disease is unknown the soil is schistose and granitic. I have always understood that in these latter soils earth-worms do not abound.

I will take upon myself to close this communication with the assurance that, if agriculturists desire it, the carbuncular disease will soon be a thing of the past, because this disease is never spontaneous, and can only be found where it has been deposited, and where its germs have been disseminated by the innocent complicity of earth-worms; and, finally, that, in any locality, it will soon disappear unless the causes of its propagation are maintained.

On the proposition of M. Thenard, the Academy decides that the paper of M. Pasteur will be sent to the Minister of Agriculture and Commerce.

PROCEEDINGS OF SOCIETIES.

NEWCASTLE-UPON-TYNE LITERARY AND PHILOSOPHICAL SOCIETY.

October 20, 1880.

"*Electric Lighting*," by Mr. J. W. Swan.

The Lecturer commenced by saying that at the time of his last lecture on Electric Lighting, almost two years ago, the public mind was greatly perturbed by the question whether or not gas lighting was about to be superseded by electric lighting.

It was generally believed that a revolution-working discovery had been made, and you may remember, as a consequence, gas stock was much depressed in value. After a while, when the supposed wonderful discovery dwindled pnd paled in the daylight of scientific examination, the anic subsided, and then the current of feeling drove the other way, and in place of the hasty credulity which at first took possession of the public mind, there is now, I think, an equally unreasonable *unbelief* in the possibilities of electric lighting—the idea now widely prevailing that electric light, as a substitute for gas, is after all a delusion.

In tracing the progress of electric lighting during the last two years, the Lecturer endeavoured to give some reasonable *grounds* for forming an opinion on the question whether or not there is a prospect of electric light being made useful to us for lighting our streets and houses, and, therefore, to what extent it may probably compete with gas light.

After some introductory remarks on the general principles governing the production of powerful electric currents by the dynamo-electric machine, the lecturer said that it was practicable to develop 1 horse-power by the combustion of 2 lbs. of coal per hour, and to produce with this amount of motive power a current of electricity sufficient to give a light of over 1000 standard candles. That is to say, we can maintain for one hour an electric light more than equal to 1000 standard candles, or 66 large gas-burners, by the combustion of 2 lbs. of coal. That is a much more economical result than can be obtained by the voltaic battery, or any other means of generating an electric current at present known.

The method of storing up electricity on the principle of Planté's secondary battery was next alluded to, and the adoption of some such means as this was advocated to perform the same part in a general system of electric lighting that the gasometer performs in gas lighting.

After briefly describing the newest forms of thermopile, one of which, the Clamond, was said to have maintained four electric lights, each of 220 standard candles, by the combustion of 21 lbs. of coke per hour, Mr. Swan passed on to speak of the different ways of applying currents of electricity to the production of light in the following words:—

"All the various means of producing light by electricity that can make any pretension to practicability are divisible into two classes, namely:—

1st. Lighting by the electric arc.
2nd. Lighting by incandescence.

In lighting by the electric arc, there is a break or gap in the circuit which has to be bridged over by a sort of electric flame. In lighting by incandescence there is no break or gap at the point where light is produced, but a thin highly infusible and badly conducting solid substance is there interposed, which becomes white hot, and emits a light bright in proportion to the degree of heat produced in it.

Now, to fix in your mind precisely what I am talking about, I will first show you what I mean by the electric arc. This will enable you more easily to follow my remarks on the question of electric lighting by this method.

Here is an enlarged view of the electric arc,—here are the two carbon points, and here—between them— is formed the electric arc.

A powerful electric current, produced by a gas-engine and dynamo-electric machine, is supplied to these two pencils of carbon through thick copper conducting wires, and you see that a stream of flame is flowing or rushing between them. If the points are too much separated the light is lessened; by increasing the air-space between the points, resistance to the passage of the current is increased, and the current is consequently diminished, and when this diminution of current passes a certain limit the light is lessened. On the other hand, when the points are made to approach too closely to each other, the light becomes less for the opposite reason.

A certain amount of difficulty or resistance must be offered to the passage of the current in order to produce light, and to get the best effect the resistance must neither be too much nor too little.

When the points are made to touch, there is no longer the resistance of the air-space to be struggled through; the light consequently goes out.

Observe the alteration in the points; they burn away,

and one faster than the other. Now as the production of a steady light demands that the points should be maintained at a constant distance apart, it is evident that under the complicated conditions of the case a nice regulation of the distance of the points to each other is a matter of extreme difficulty.

I will now ask for the current to be turned on to a lamp hung up aloft, in order that you may see how very nearly the difficulties of producing a steady arc light have been surmounted.

The particular lamp I am using for the purpose of my illustration is Crompton's lamp, of which here is a diagram. Properly regulated it feeds the pencils together almost continuously and with great precision.

That then, ladies and gentlemen, is "par excellence" *The Electric Light.* That is the form and style of electric light that inventors have for the last forty years struggled and battled with difficulty upon difficulty to render serviceable to the wants of man.

From the nature of the electric arc light you will readily perceive that it is a kind of light not suited to the lighting of dwelling-houses, nor shops, nor streets. It does not lend itself kindly to division nor extensive distribution. It will give you either a great deal of light or none.

For certain exceptional uses it is excellent. If you want a very brilliant illumination all centered in one focus—for a lighthouse, or signal, for example, or for a high-roofed railway station, or very large workshop, or open space—it is unquestionably the most economical and the best of all artificial lights.

It has already found for itself in England over 200 appropriate applications. Its use is continued and increased on the Thames Embankment. It is used in the reading-room of the British Museum; in the Picton Library, Liverpool; in a portion of the South Kensington Museum; at the Liverpool Road Railway Station; the Barrow Shipbuilding Works; the St. Enoch Railway Station, Glasgow; on the Promenade at Blackpool; and at the New Albert Docks, where, by means of Siemens's lamps, three miles of wharfs and quays are made almost as light by night as by day, and at a very moderate cost.

As an illustration of the economy of lighting by means of the electric arc under conditions suited to its use, I instance the case of the Alexandra Palace, where 2000 gas-lights, which consumed 26s. worth of gas per hour, are replaced by six of Mr. Crompton's lamps, giving a greater aggregate amount of light than the 2000 gas-burners, at a cost of 6s. per hour. In some instances the economy of the electric arc light is greater by half than in the case I have mentioned. Not only is it economical in such a case as that of the Alexandra Palace, but it produces an effect of general illumination overhead as well as upon the ground not producable by any other means.

But the interest which attaches to electric arc lighting is much lessened by the fact that the purposes to which that mode of lighting is suited are exceptional. We do not as a rule want the light of 1000 candles or more all in one place. What we do generally want is a number of small and steady lights, spread about in different rooms, and in different parts of those rooms. For electric light of this description we must search in another direction.

I said that there is *another way* of producing electric light; namely, by *incandescence.*

Lighting by incandescence is a branch of the subject which has a special charm for me, because I have bestowed upon it much thought and labour; and it is I believe *the* branch which will yield the largest crop of fruit. Electric lighting by incandescence is just as simple as arc lighting is difficult; all that is required is a material which is not a very good conductor of electricity, highly infusible, and which can be formed into a wire or lamina, and is either non-combustible in air, or, if combustible, does not undergo change in a vacuum. There are, so far as I know, just two substances that possess, in any sufficient degree for the purpose in question, the qualities I have specified.

The two substances are:—Platinum, or an alloy of platinum with iridium; and carbon. Platinum has the advantage over carbon that it is not combustible in air; it does not, like carbon, burn away if you make it white-hot; but it is very inferior to carbon in the degree of heat it will bear without fusion; and for producing light by incandescence it is essential to economy that the incandescent material should be capable of enduring an extremely high temperature, because the amount of light emitted by an incandescent substance increases in a more rapid ratio than the temperature.

When, for example, you have a piece of platinum wire or carbon red-hot it emits almost no light, but double its temperature by sending a double quantity of current through it, and it will yield much more than twice the light it did before.

It is therefore evident that the hotter the incandescent material can be made the less the light will cost per unit of power expended.

Iridio-platinum, comparatively with other metals, may be called extremely infusible, but compared with carbon it is nowhere. Carbon has in fact resisted without fusion the very highest degree of heat brought to bear upon it; and what that degree of heat is I can hardly estimate, it is so enormous.

But carbon has been found so difficult to deal with, on account of its ready combustibility (and some other troublesome properties which I will mention afterwards), that experimenters have bestowed much attention upon platinum and iridio-platinum as the incandescent material for electric lamps.

Mr. Edison was, I think, the last who attempted to utilise platinum in an electric lamp, and I think there can be no doubt that he obtained better results with platinum, and came nearer making a useful platinum lamp, than any experimenter in the same track who had gone before him.

Here is a view of Edison's platinum lamp.

This is the lamp of which so much was promised and expected in October, 1878, and which led, you remember, to the panic in gas shares. This lamp did not realise the hopes of the inventor.

(I will not re-kindle Mr. Crompton's Electric Sun, because I hope presently to show you some small lamps whose light would be absolutely drowned in that fierce radiance, as stars are by the light of day.)

Whilst Mr. Edison was endeavouring to produce a useful incandescent lamp by means of platinum, I was endeavouring to obtain the same end by means of carbon.

It had appeared to me for many years that if ever electric light was to become generally useful, it would, most probably, be by means of the incandescence of carbon. I had, long before the time to which I am referring, attempted to render this idea practicable.

As a matter of history, I will briefly describe an experiment which I tried about twenty years ago:—

I had a number of pieces of paper and card, of various forms and sizes, buried in charcoal in a crucible. This crucible I sent to be heated white-hot in one of the pottery kilns belonging to Mr. Wallace, of Forth Banks. From the pieces of carbonised card which I thus obtained I selected a long spiral; the ends of this I clipped between small blocks of carbon carried by uprights, and connected with conducting wires. A small glass shade was cemented over this mounted carbon spiral, and the air was exhausted by means of a very good air-pump, lent to me for the purpose of this experiment by the Rev. Robert Green, of Longhorsley. A good vacuum (according to the ideas that then prevailed) having been produced, I applied the wires of my battery (consisting of 10 cells of Callan's modification of Grove's Battery) with great expectation of a brilliant result: instead of this there was the most absolute negative presented to me; not a vestige of heat or light appeared in my long ringlet of carbonised paper. It was evident, and I immediately recognised the fact, that the electric current of the strength I was using would not go in sufficient quantity through so long a piece of carbon as I had taken. I therefore repeated the experiment with

shorter carbon and a greater number of cells, and I obtained, under these altered circumstances, an extremely interesting result.

My carbon was in the form of an arch (this diagram will help my explanation), about one inch high and quarter of an inch wide. The ends of the arch were held in small clamps, with square blocks of carbon.

The air-pump having been worked, I had the pleasure of seeing that when contact with the battery of 40 or 50 cells was completed my carbonised paper-arch became red-hot, and it was evident that nothing more was wanted than a still stronger current to make it give out a brilliant light; but I had used up all the battery power at my disposal, and having reached this limit I contented myself with watching the behaviour of the arch, the engrossing question being—How long will it endure?

I noticed that the inner part of the arch was hotter than the outer part, and that—perhaps in consequence of this—the arch became bent on one side. This bending gradually increased, until at last the arch had so far curled down that the top was on a level with the clamps, and on coming in contact with the sole of the lamp it broke in two, and the experiment collapsed.

That, I confidently believe, was the very first instance in which carbonised paper was ever used in the construction of an incandescent electric lamp.

I am now speaking of twenty years ago, and at that time the Voltaic battery was the cheapest source of electricity known, and the means of producing high vacua were very much less perfect than they are now.

I laid my electric light experiments aside until about three years ago, when two things concurred to lead me to pursue the object afresh.

The discovery of the dynamo-electric machine had entirely altered the position of the question of electric lighting, shifting it out of the region of things scientifically interesting into that of things practically useful.

The Sprengel air-pump, too, had been invented, and with its invention we had been provided with a means of producing much higher vacua than could be produced by the old form of air-pump.

Mr. Crookes's radiometer experiments had shown us what a really high vacuum was, and how to produce it.

Mr. Stearn, of Birkenhead, an ardent scientific amateur, was so attracted by the extraordinary results Mr. Crookes had obtained by means of high vacua as to go with great enthusiasm into the same line of experiment, and he soon acquired such a knowledge of the Sprengel pump, and such expertness in its manipulation, as perhaps was only equalled by Mr. Crookes himself.

I had the good fortune to make Mr. Stearn's acquaintance, and that was the other one of the determining causes of my second attempt to solve the problem of electric lighting by the incandescence of carbon.

In the interval between the first and second periods I have mentioned, many attempts had been made by various experimenters to render practicable incandescent carbon lamps, but none were entirely successful.

Here is represented a variety of the most notable of these attempts. Some are vacuum lamps, and some have air admitted. Sawyer and Mann's lamp is filled with nitrogen. When the incandescent carbon is in air it burns away, and must consequently be renewed just as a candle must be renewed; it must also be thicker than would be necessary in a vacuum, and being thicker it requires a proportionally greater current to render it incandescent: both these circumstances are obviously against economy.

The André lamp is one of the best of this type. In this the supply of air is limited; still this lamp and all those lamps are lacking in simplicity and in economy.

In all the various attempts to utilise the principle of the incandescence of carbon in vacuo, two great difficulties had stood in the way, and baffled every attempt to overcome them. One was *the rapid wearing away, and consequent breaking, of the incandescent carbon*; and the other *the obscuration of the lamp by a kind of black smoke*. So uniformly did these phenomena present themselves that the idea was propounded and generally accepted that the blackening of the lamp-globes was due to volatilisation of the carbon under the action of the enormous heat to which it was subjected.

In Fontaine's work on electric light this passage occurs at page 180:—"Attentive examination of incandescent carbons, through a strongly coloured glass, has shown that they are not uniformly brilliant. They present obscure spots indicative of non-homogeneity and the position of cracks, which rapidly disintegrate the carbon. The vacuum never being perfect in the receivers, the first carbon is in greater part consumed. It would appear that, consequently upon the little oxygen contained in the lamp being transformed into carbonic acid and carbonic oxide, the carbon should be preserved indefinitely. But there is *then* produced a kind of *evaporation* which continues to slowly destroy the incandescent rods. This evaporation is, besides, *clearly proved* by *a pulverulent deposit of sublimed carbon, that we have found on the interior surface of the bells, on the several interior parts, rods, contacts, hammers, &c.*"

If this idea of the volatilisation of carbon were founded in fact, any further attempt to render incandescent carbon lamps *durable* by means of a vacuum were *mere waste of time*, and durable they *must* be if they were to be of any practical value.

Fortunately I did not accept as conclusive the experiments which seemed to show that carbon was volatile, and that the blackening of globes of incandescent carbon lamps was an inevitable result of the carbon being very highly heated. I know that the conditions under which, without exception, all previous experiments had been tried were such as did not allow to be formed anything approaching a perfect vacuum within the lamp. Screw fittings had invariably been employed to close the mouth of the lamp, and the ordinary air-pump to exhaust the air. Under such circumstances it was certain that a considerable residuum of air would be contained within it, and also that it would leak. Then, there had never been any thought given to the gas occluded in the carbon itself, and which, when the carbon became hot by the passage of the current through it, would be evolved; nor had sufficient care been taken *to make the resistance, at the points of fixture of the carbon, less than in the carbon to be heated to incandescence.*

It was evident to me that before any definite conclusion could be arrived at as to the question of the volatility of carbon, the cause of the blackening of the globes, and the wearing away of the incandescent rods, *we must first try the experiment of heating the carbon to a state of extreme incandescence in a thoroughly good vacuum* (such as Mr. Crookes had taught us how to procure), *and under more favourable conditions as to the contact between the incandescent carbon and the conductors supporting it than had hitherto obtained.*

Accordingly, in October, 1877, I sent to Mr. Stearn a number of carbons, made from carbonised cardboard, with the request that he would get them mounted for me in glass globes by a glassblower, and then exhaust the air as completely as possible. This delicate operation Mr. Stearn very kindly undertook and very skilfully carried out.

In order to produce a good vacuum it was found necessary to heat the carbon to a very high degree by means of the electric current *during the process of exhaustion*, so as expel the gas occluded by the carbon in its cold state, for otherwise, however good the vacuum was before the carbon was heated, immediately the current passed and made it white-hot, the vacuum was destroyed by the outrush of the gas pent up in the carbon in its cold state. In order to make a good contact between the carbon and the clips supporting it, the ends of the carbon were thickened, and, in some of the early experiments, electrotyping and hard soldering of the ends of the carbons to platinum was resorted to.

I will not weary you, however, with details, but simply

say that the prescribed conditions having been rigorously complied with, it was found, after many troublesome experiments, that *when the vacuum within the lamp globe was good, and the contact between the carbon and the conductor which supported it sufficient, there was no blackening of the globes, and no appreciable wasting away of the carbons.*

Thus was swept away a pernicious error, which, like a lying finger-post, proclaiming "No road this way," tended to bar progress along a good thoroughfare.

It only remained to perfect the details of the lamp, to find the best material from which to form the carbon, and to fix this material in the lamp in the best manner. These points, I think, I have now satisfactorily settled; and you see the result in the lamp before me on the table.

It is a very modest looking affair, but its performance goes beyond its appearance. The carbon is extremely thin—a mere hair,—and how wonderfully strong and elastic it is I will endeavour to show you by means of the lantern.

This carbon unlike the carbon spoken of by Fontaine, in the extract I read to you, is quite homogeneous and almost flinty in hardness, and it becomes harder by use in the lamp; the longer and the hotter it is heated, the harder it becomes, What degree of hardness it will ultimately arrive at is an interesting question.

Here is a magnified view of the carbon ring in a state of incandescence; observe how absolutely uniform in brightness it is; that proves it to be homogeneous and foretells its durability.

Now I will show you how easily lamps of this kind are lighted, and how completely this form of electric light can be divided and distributed.

Is it not a pleasant light? It is not so white as the arc light, but yet a whiter light than gas. Colours are correctly seen by it, as this picture shows. But the great merit of this light consists in its not being in contact with air, and therefore there cannot possibly be the slightest air pollution caused by it. The rooms in which this light is used will be as pure by night as by day.

It is essential to economy in lighting by incandescence that the incandescent carbon should be very thin. The carbon I use is not one-twentieth the thickness of the thinnest of the carbons formerly employed, and therefore one-twentieth of the current, costing one-twentieth the price, will produce in my thin carbon the same degree of luminosity as twenty times more current will produce in such carbons as were used in those ancient lamps.

You will notice that in my lamp leakage is very thoroughly guarded against. The wire which passes through the glass not only having the glass fused around it where the wire and globe meet— but in addition to this, the wire is coated with glass almost up to the carbon. In this way the vacuum is preserved very effectually.

You have, of course, all heard that after Mr. Edison abandoned his platinum lamp as impracticable, he invented a new lamp in which carbonised cardboard is used.

Here is a diagram of Mr. Edison's carbon lamp, with its horse-shoe of carbonised paper. It is in some respects like mine, but latterly I have given up the use of carbonised cardboard, and am now using a material as much better than carbonised cardboard as carbonised cardboard was better than the material previously used. In an article which appeared in the February number of *Scribner's Magazine*, authenticated by a letter from Mr. Edison in the same publication, it is stated that Mr. Edison was the first to use carbonised paper; that is incorrect. And this also occurs after a description of the Sprengel pump used in exhausting these lamps:—"Mr. Edison's use of carbon in such a vacuum is entirely new." Now I daresay there are many here who will remember this little lamp, which I showed here two years ago in action. This lamp has exactly the same simplicity as my present lamp, being composed entirely of three substances, namely, glass, platinum, aud carbon, and it was exhausted in precisely the same manner, and to the same degree, as that which Mr. Upton—no doubt in good faith but still in error—speaks of as "*entirely new.*"

I do not mention these things in any way to disparage Mr. Edison, for no one can esteem more highly his inventive genius than I do. I merely state these facts because I think it is right to do so in my own interest, and in the interest of true history.

The complete seclusion of the light in this lamp from contact with air suggests its adaptability to coal mine illumination, and I earnestly hope that this may prove to be one of its uses.

But the great purpose to which a lamp of this kind is applicable is the lighting of your houses. In view of such an application—two all-important questions present themselves:—one, as to distribution, another, as to cost.

Can this light be divided, distributed, and measured as gas is divided, distributed, and measured? And at what cost? It is quite impossible in a brief lecture to discuss these questions exhaustively, but as far as is possible, in a few words I will answer them.

1st. Then, as to division and distribution, it has been asserted on very high authority that great loss necessarily attends the division of the electric light. To a certain extent this is true of lighting by the electric arc, but it is totally and absolutely erroneous of lighting by incandescence. *There is no less in dividing the electric light produced by this means.* Faraday has stated the law of the case in these words: "An electric current which will heat one inch of wire *white hot*, will also heat to the same temperature 100 inches, or an infinite length of the same wire." There is no question of the truth of this. Now, as it is only necessary, in order to maintain a given current, to increase the force which produces it in the same proportion as you increase the resistance to its flow, it follows that the cost of raising to a certain degree of incandescence a longer or shorter length of carbon or of maintaining a 10 candle-light or 100 candle-light will be exactly proportional to the light produced. You may even contemplate on this principle the economical production of an electric light as small as a rush-light. A certain unit of light may be established in an indefinite number of places, with no greater aggregate expenditure of power than that directly and simply proportional to the number of light.

With regard to distribution, I believe that it will prove to be practicable to light any large town—all Newcastle, for instance—by means of wires laid in the ground as gas-pipes are laid, and all branching from one centre, and conveying the electric current to lamps like this.

The lamps now lighted are supplied by a current coming from generators working at the far end of Mosley Street (a quarter of a mile away), and it would be just as easy by using a more energetic current—a current, as it were, under higher pressure—to maintain these several miles away, and for this purpose the conductors need not be large, not so large certainly as to make the distribution of electric current more costly than the distribution of gas.

For supplying large towns with electric light, Mr. Edison proposes to have a number of centres for the supply of electric power, perhaps a quarter of a mile apart, whence wires would be sent out in every different direction, distributing the current to the houses round about. His plan of distribution is this. He proposes to send out bundles of main wires from each of the centres of supply, and from these main wires to branch as many small wires into the houses as there are lamps to be lighted, each branch wire proceeding from a main wire to the place where the lamp is situated, and from thence to a return main wire.

Now although this plan has the great merit of simplicity, I do not think it will answer, except for very short distances.

When a number of lamps are grouped together in that manner, it is necessary that the individual lamps should offer a very high resistance to the current, for if each lamp does not offer an extremely high resistance to the passage of the current there must be great waste, a large propor-

tion of energy being in that case spent in heating the conducting wires, instead of the carbon in the lamps.

Mr. Edison accordingly proposes to make his lamps of a very high resistance. He proposes to use for the incandescent material a form of carbon which offers a higher resistance than simple carbon in its compact state; but if carbon pure and simple is used, then I submit it had better be in as stable and condensed a state as possible, because in process of use it tends to consolidate, and it is undesirable that any change should take place in the lamp during use.

The resistance offered by a filament of carbon in its best state for incandescent lamps, as thin as it is safe to use in a lamp, and of a length sufficient to give, say, a light equal to one burner, or 10 standard candles (a unit of light which I think we must not go beyond in planning an extensive system of town lighting), will not offer so high a resistance as that which Mr. Edison has made the basis of his scheme of distribution.

With lamps of this resistance, the result would be that before many were bridged across from one main wire to another, as much or more work would be done in the conducting-wire as in the lamp. The only way of avoiding this waste of energy, without abandoning the idea of small units of light, would be either to employ enormously thick conductors, or have a very limited area supplied from one works.

I think the difficulty is capable of being surmounted in this way:—Instead of grouping the lamps as Mr. Edison proposes, each lamp being as it were a loop or bridge between two mains, I propose to string them in series—10, 50, or perhaps 100 lamps being all interposed in one and the same line. In this way every lamp would *add* to the resistance of the line, instead of, as in Mr. Edison's plan, *diminishing* its resistance. The waste of energy in the conducting wire would thus be avoided.

A copper wire, less than one-eighth of an inch thick, would supply current for one such series of (say) from 10 to 100 lamps, at 5 miles distance, with a very small percentage of loss; while to supply at the same distance a corresponding series on Mr. Edison's plan would demand copper conductors of such thickness as would certainly make the plan far too expensive; or if such thick conductor was not used, there would be an impracticably extravagant waste of energy in the wire. If even 50 per cent of the energy were expended in the wire, the size of the conductor required to transmit the current, say even 2 miles, would be far too great.

There is no way of escape that I know of from this dilemma, viz., that either we must make our unit of light larger than necessary for a very great many purposes, and so give up the idea of extensive division and extensive distribution, or, in order to gain these points, we must group the lamps in the manner I have proposed.

There are, no doubt, difficulties in the carrying out of my plan, but none that are not easily surmountable. For example, if 20, 50, or 100 lights were in a series, a break in any part of the line would extinguish all the lights. This danger can be met in two ways:—

I would have only one lamp belonging to a given line in one house, so that the extinction of such a line of lights as we are contemplating would not be a very serious mishap; but I would make such a mishap extremely unlikely to occur, by placing along with each lamp an automatic circuit closer. This would so act as to bridge over the gap made by the accidental breaking or failure of a lamp, and so prevent the extinction of the rest of the lamps in the series, while a fresh lamp was put in the place of the broken one,—a thing no more difficult, and probably not more costly, than the replacement of a broken gas-burner chimney or globe.

There is another difficulty occasioned by the variation of the current in proportion to the number of lamps in action.

What is required in this case is to maintain a uniform current in the line of lamps, whether 1 or 100 are alight. This can be accomplished by self-acting apparatus somewhat on the principle of the governor of the steam-engine, and which would automatically raise or lower the potential or pressure by steps of 100ths, according to the number of lamps in use.

I have also considered the question of measuring the current, and, if time allowed, I could show you that that could be done as easily as the measuring of gas.

Similarly, all other practical difficulties arising out of this method of distribution can be met, and being met we are at liberty to contemplate a great central works producing electricity by large steam-engines, and distributing it by means of wires to a whole town, exactly as gas is now distributed by gas-works.

I have already referred to the cost of electric light produced on the arc principle, and shown that when the circumstances are favourable to the employment of that method it is much more economical than gas-light.

The economy of lighting by incandescence has not been exemplified by so many instances of actual practical use. One thing is, however, *quite clear*, and that is, that *electric lighting by incandescence is an economical process*—it will be less costly than gas-lighting. That is conclusively demonstrated by the fact that 1000 feet of gas employed in working a gas-engine to develop an electric current, and used in my lamps, will yield more light than 1000 feet of gas consumed in the ordinary way in gas-burners. This room is now lighted by twenty of my electric lamps, and to produce the current which feeds them 160 cubic feet of gas per hour are being burnt in a gas-engine: before my lamps were kindled the room was lighted by seventy gas jets, consuming, I am told on good authority, 210 feet per hour. It is very evident that we have got more light out of the gas through the medium of electricity than was got from the larger quantity of gas which those burners consumed. Our conditions here are somewhat unfavourable to my light for a fair comparison, but from measurements carefully made—both of light produced and current required to produce it—I am warranted in saying that at least twice as much light will be produced by a certain quantity of gas used to generate an electric current employed in my lamps, than would be obtained from this quantity of gas burnt in gas-burners in the usual manner.

If that is so, then it is evident that when, instead of the motive power of gas, that of steam produced in the most economical manner is employed, this method of electric lighting will be very much less costly than gas lighting. I reckon that 40 lbs. of coal employed in raising steam to generate electricity is capable of producing in my lamps the effect of 1000 feet of gas burnt in gas-burners in the ordinary manner.

The economical part of the question is therefore, in my opinion, very favourable to electric lighting, and I think fully warrants me in anticipating an extensive substitution of electric light for gas light.

The great difficulty which till now has completely blocked the way to any general use of electric light was *the difficulty of division—that difficulty is now completely overcome*—by the method of producing electric light by the incandescence of carbon *in vacuo*, of which I have given you a practical demonstration to-night.

Now, ladies and gentlemen, if I have not exhausted my subject I certainly have exhausted your patience. I will weary you no more.

Eighty years ago Science gave us enlarged means of turning night into day. Since then not a little of our lifetime has been spent in gas-lit rooms, and it has been somewhat of a reproach to Science that she has not provided us with this larger measure of light without at the same time imposing on us the necessity of breathing a vitiated atmosphere.

To-day Science vindicates herself: henceforth we may make the long nights of our northern winter bright without any such sacrifice.

NOTICES OF BOOKS.

The Electric Light for Industrial Uses. By R. E. Crompton. London: Mansion House Buildings.

We have here an account of the various systems of electric lighting, with their respective advantages and defects, the area illuminated by each light, and the hourly cost. For estimating illuminating power he adopts the three standards proposed by Mr. Preece. In the first, any fine work may be carried on which usually requires a gas-jet at a distance of 2 or 3 feet. In the second, a newspaper can be read with comfort, and the third is rather better lighted than by a clear full moon, so that excavating, levelling, loading waggons, &c., can be carried on. A table is given showing how many square yards can be lighted up to each standard per lb. of coal burnt. It appears that the A Gramme machine lighted up 33 square yards to the first standard, 166 to the second, and 850 to the third. A B Gramme lighted 18 yards to the first, 100 to the second, and 4000 to the third. The different colours of the light produced —a point of capital importance in dye- or print-works— are incidentally mentioned. The single lights burned on the low tension currents of Siemens, Gramme, or Bürgin are said to be very white and pure, colours seen by the light being exceedingly true to sunlight. If the tension is increased and the quantity of the current diminished, several lights may be burnt in series, but the rays are often coloured purple, blue, or greenish, and the light is flickering and unsteady. A Gramme machine with a resistance of 1 ohm gives a current suitable for producing a stable arc ¼ inch long with a very pure white light. This arrangement appears to be recommended where colour and steadiness are important.

The Brush machines are described as capable of maintaining 16 arcs in series, but they are deficient as regards colour and steadiness. The penetrating power of the lights in foggy weather is not satisfactory.

Important information is given as to the choice of carbons. Those of Carre and Siemens are apt to give a colour to the light. Those of the Brush Company give an extremely white light, but the Company will not supply them for use in other systems. The best were produced by Gaudoin, but his secret died with him. Where motive power has not to be specially obtained, the cost of the A Gramme light and of the D^6 Siemens is given at 6d. per hour as a fair average. The B Gramme and D^2 Siemens average 10½d.

We hope that this pamphlet will subserve the extension of electric lighting.

Report of the Explosives Committee appointed jointly by the Royal Cornwall Polytechnic Society, the Miners' Association of Cornwall and Devon, and the Mining Institute of Cornwall. Truro: Lake and Lake.

The object of the Committee was to examine the nature, economy, efficiency, and safety of explosives, confining the enquiry to such as are in actual use or likely to be used in the mines of Devon and Cornwall. These appear to be gunpowder, Espir's explosive powder, gun-cotton, tonite, titanite, dynamite, blasting-gelatin, Liverpool cotton-powder. Concerning the composition of these agents the following information is given:—The gunpowder consists of charcoal 15 per cent, sulphur 15 per cent, and nitre 70 per cent. An especially strong gunpowder is also mentioned, the composition of which is not stated. Espir's powder consists approximately of 60 per cent nitrate of soda, 14 of sulphur, and 26 of hard wood sawdust. The gun-cotton is of the ordinary nature, but its percentage of trinitro-cellulose is not stated. Tonite is said to be gun-cotton combined, or rather mixed, with barium nitrate. Concerning the product which bears the misleading name "titanite" no information was obtained. Two kinds of dynamite were examined, No. 1 consisting of 75 per cent nitro-glycerin and 24 per cent "kieselguhr," whilst No. 2 contains less nitro-glycerin, and varying proportions of charcoal and a nitrate. "Blasting-gelatin," which is misnamed, as it contains no gelatin, is made of 7 to 10 parts collodion-cotton mixed with 90 to 93 parts of purified nitro-glycerin. Lastly, the Liverpool cotton-powder is said to be a mixture of gun-cotton with potassium nitrate.

From lack of funds the Committee made only two series of experiments to try the relative efficiency and economy of the explosives as used in hard ground and in driving levels for successive periods of not less than a week. In these series gun-cotton, titanite, and blasting-gelatin were not tried. In the first experiments the cost per foot of hole with common powder was ¾d., with compressed powder and Espir's powder 1d. each, Liverpool cotton-powder 2d., tonite 2½d., special strong powder 3d., and dynamite 3½d. In the second series the total cost per foot ranged from 5d. to 1½d. with compressed powder to 8d. to 6¾d. with tonite.

The remaining labours of the Committee consisted in sending enquiries as to the respective merits and drawbacks of the different explosives, and in receiving replies, which are in many cases very conflicting. As to the relative cost of explosives for doing an equal amount of work, the majority of the answers seem to have been in favour of dynamite. One consumer said that he had known gun-cotton lose one-third of its strength when kept in a dry magazine, a result not easily intelligible. All the authorities except two agreed that the fumes from dynamite are the most injurious. The Committee point out that a serious accident—*i.e.*, that at Halkyn Level, April 10, 1878—was due to the published statement that "in close workings the absence of smoke or noxious gases renders the use of gun-cotton doubly valuable." A similar impression prevails as regards dynamite.

According to the official returns of H.M.'s Inspectors of Explosives, here quoted, the year 1878 was marked by 43 accidents, of which 4 are due to tonite, 2 to gun-cotton, 16 to dynamite, and 21 to gunpowder. These figures obviously throw no light on the relative danger.

It is much to be regretted that the Committee was not provided with the means to make an exhaustive series of experiments on all the explosive compounds and mixtures now offered for sale in England.

Fourth Annual Report of the Proceedings of the Aberdeenshire Agricultural Association. Season 1879—80.

Mr. Jamieson, F.C.S., Chemist to the Association, communicates in his report certain very interesting results. Thus, phosphates of lime "pure simple," differ little in their efficacy whether they are of animal or mineral nature, ground coprolite being substantially equal as a turnip-manure to ground bone-ash. A mixture of such ground coprolite with about one-third its weight of steamed bone-dust may, the author considers, be used with economy and advantage, though acting more slowly than certain other phosphates.

A second conclusion is that soluble phosphate is not superior to insoluble phosphate to the extent commonly supposed. Mr. Jameison does not mean to say that soluble phosphate is hurtful or needless. He recommends it in small proportions along with the insoluble, but he estimates its superiority at nearer 10 than 100 per cent. Dr. Aitken, the chemist to the Highland and Agricultural Society, comes to a very similar conclusion. Thus the crop from a plot of land manured with insoluble phosphate weighed 19 tons 13 cwts. Similar plots dressed with dissolved coprolite yielded 22 tons 3 cwts., with dissolved Curaçoa phosphate 20 tons 17 cwts., and with dissolved bone-ash only 19 tons 7 cwts. Thus the average result of the dissolved over the undissolved phosphate is only 6 per cent.

The experiments of Dr. Voelcker, undertaken to test these views, are far from sustaining the conclusion expressed by the learned doctor that:—"Mineral phosphates scarcely produce a visible effect on vegetation." It is

scarcely needful to say that if the Aberdeenshire results are found to be corroborated by further trials on other soils and under other climates, and as regards other crops besides turnips, both the manufacture of artificial manures and their analytical valuation must be greatly modified. The following, *e.g.*, is the scale of values adopted by the Kirriemuir Agricultural Association. The phosphate in minerals, or in mineral superphosphate, is valued, if insoluble, at 0 per unit, but if dissolved at 3s. 3d. In animal superphosphate the values are respectively 1s. and 3s. 7d, and in dissolved bones 2s. 9d. and 4s.

If soluble phosphate is found in practice to exceed the insoluble in value only by 6, 7, or 8 per cent, and has to be sold accordingly, it will scarcely be worth preparing. The author finds, further, that the phosphates of alumina and iron exerted little or no influence upon the crops. In the use of insoluble phosphates "it is of course essential that they should be applied in a fine state of division." Bones ground to $\frac{1}{2}$, $\frac{1}{4}$, or even $\frac{1}{8}$ inch cannot be fairly compared with superphosphate.

CORRESPONDENCE.

THE SPECIFIC ROTATORY POWER OF CANE- AND INVERT-SUGAR.

To the Editor of the Chemical News.

Sir,—Mr. Allen has done well to call attention to the discrepancies and confusion in the statements relating to the specific rotatory power of cane- and invert-sugar. I have, in my practice, occasion to polarise a large number of samples of sugar; during the last two years I have done several thousand analyses of this kind, but nearly always by the direct method. I have repeatedly tried to obtain results by the method of inversion (according to the specific rotatory power = −25), but in no instance have I been able to obtain correct results, although every precaution was used in the experiments. I at last gave up in despair, not knowing what to think, because the statements given in the text-books, and in special papers, on good authority, are so clear and definite. But Mr. Allen's paper brought up the matter again in my mind, and influenced me to make the experiments that are given below. I think it will easily be made clear that there is a thread of confusion running through much that has been written on this subject. Mr. Allen says in his paper:—"According to the observations generally accepted, the angular rotation produced on a ray of polarised light by a plate of quartz 1 millimetre in thickness is 24 angular degrees for the mean yellow ray or transition tint." If this is the true rotatory power of quartz, and if 12·26 grms. of sugar dissolved to 100 c.c. in water have a rotatory power equal to the plate of quartz when observed in a column 2 decimetres long, then the 16·26 grms. of sugar rotate through 24 angular degrees, and calculations based upon this assumption will give true results. But, as Mr. Allen states at the end of his paper,—"Broch has found the deviation produced by a thickness of 1 m.m. of quartz equal to 21·67 for the sodium ray, while Gerard and De Luynes take the same value as 21·8. Brown and Heron adopt the number 21·54. Tollens gives the number 66·5 as the value of S_D for cane-sugar solutions containing 10 per cent and upwards, a value which corresponds to 21·63. The mean of these four determinations is 21·66." I have made one experiment with pure sugar, and found the value to be 21·62, which agrees closely with the results quoted. The practice in graduating polariscopes seems to be this:—The maker takes a plate of quartz 1 m.m. thick, or a solution of pure sugar, and marks the point to which this rotates 100, and divides the intermediate space into 100 parts. This is a very different thing to taking 24 angular degrees and sub-dividing them into 100 parts, that is, if the quartz or sugar does not rotate through 24 degrees, but the same thing if it does.

I have had no opportunity of reading Tuschmidt's papers, but I have looked through that of Casamajor, and I think I am right in saying that he makes no reference to angular degrees, but only to the empirical degrees of Soleil, probably because his instrument was not graduated in anything but sugar percentages. But when we come to calculate the specific rotatory power of sugar, it is necessary to insert the angular degrees, and then the confusion comes in, because in most instances the number 24 has been used, which is, as we have seen, too high. The values for the specific rotatory power of cane- and invert-sugar must be multiplied by 0·90 (as Mr. Allen says) to give the correct results; this brings the value of cane-sugar to very near 66·45, instead of 73·8.

I have written on this point because of late, no doubt owing to these errors the practice of inverting sugars has much diminished, which is to be regretted. Although the graduation of Soleil's instrument does not depend upon angular degrees as far as the right hand portion of the scale goes, I am of opinion that in some instruments the left handed part of the scale does so depend, because, with a Soleil polariscope I had, the results were always considerably too low when the inversion method was employed. The following are the results of my experiments. The sugar used was a very fine sample of white candy, dried at 100° C.

(1.) 16·26 grms. dissolved to 100° C. without inversion gave +21°37′, +21°37′, +21°38′. This corresponds to 21·62°, and to a specific rotatory power 66·45.

(2.) 10 grms. dissolved to 100° C., after inversion with 10 c.c. of strong hydrochloric acid at 68·72 (boiling gives no higher results), gave—

−4°49′ at 11° C. (= S_D −22·88)
−4°43′ at 13·5° C. (= S_D −22·44)
−4°45′ at 13° C. (= S_D −22·56)

(3.) Another experiment gave—

−4°46′ at 11·5° C. (= S_D −22·64)
−4°45′ at 12·5° C. (= S_D −22·56)
−4°40′, −4°41′ at 14° C. (= S_D −22·20)
−4°36′, −4°37′ at 15° C. (= S_D −21·89)
−4°33′, −4°34′ at 16° C. (= S_D −21·69)

(4.) In another experiment the results were—

−4°40′, −4°41′ at 14° C. (= S_D −22·18)
−4°39′ at 15° C. (= S_D −22·09)
−4°35′, −4°35′ at 16° C. (= S_D −21·77)

The experiments were conducted with the usual precautions. A special tube surrounded by a water jacket was used to control the temperature. The polariscope employed was one of Schmidt and Hencke's direct rotation instruments, graduated in degrees as well as sugar percentages, and constructed for use with the sodium flame. These instruments are better, cheaper, and more accurate than the colour instruments, and are, unlike the latter, adapted for use with other substances than cane sugar. The results agree fairly well with those of Casamajor and Tuschmidtt when the correction is made for the angular degrees.—I am, &c.,

Thomas Bayley.

REPLY TO MR. WELDON.

To the Editor of the Chemical News.

Sir,—I take the liberty of requesting you to insert in the correspondence portion of your esteemed paper the notice that, after the approaching conclusion of my experiments,

a reply will be given to the attacks of Mr. Weldon. I would further remark that it is not my intention to claim or to make use of the columns of your journal for a controversial expression.—I am, &c.,

Julius Post.

SOCIETY OF INDUSTRIAL CHEMISTS.

To the Editor of the Chemical News.

Sir,—Some six months ago I observed that you had a notice of a proposed Society of Industrial Chemists, but since that time I have been unable to learn that any further steps have been taken for the starting of the society. It appears to me, as a manufacturing chemist, that some such society is greatly needed, and I trust that the project has not been given up. I think that if started on a proper footing, it would do a great deal of good to the profession, and that it would command the support of the great proportion of chemists engaged in industrial pursuits.—I am, &c.,

Northern Chemist.

Edinburgh, October 30, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 15, October 11, 1880.

The Part Played by Time in the Formation of Salts.—M. Berthelot.—The part played by time in chemical reactions was formerly overlooked, or ascribed to the want of contact and of homogeneity, and in any case regarded as of little importance. It was especially brought under the notice of chemists in consequence of the author's researches (1854) on the synthesis of neutral fatty bodies and of polyatomic ethers, resulting from the union of acids and saccharine principles, compounds formed simply by the prolonged contact of the reacting bodies. These and subsequent researches show the distinction which exists between ethereal reactions, slow and progressive, even in homogeneous systems, and the saline reactions, the duration of which is so short in the majority of cases that it escapes our present means of measurement. Whenever an acid dissolved in water is caused to act upon a dissolved base or salt, or a dissolved base upon a dissolved acid or salt, or two dissolved salts the one upon the other, whenever the resulting products are equally soluble and form a homogeneous system, the reaction does not in general require for its completion any appreciable interval of time further than is necessary to effect the exact mixture of the two liquids. The author shows how slow chemical changes may be detected and measured by thermic methods. The chemical equilibrium so rapidly established in dissolved saline systems seems correlative with the electrolytic conductibility which characterises such systems.

Photophonic Experiments of Prof. A. G. Bell and M. Sumner Tainter.—A. Breguet.—This paper cannot be reproduced without the accompanying illustration. The question arises whether it is light or heat which is brought into play. M. Bell has placed before the pencil of rays a solution of alum and then a solution of iodine. In the former case the sonorous effects were little reduced in intensity, whilst in the latter scarcely any sound was heard.

Mechanical Actions of Light; Theoretical Consideration Serving to Interpret the Experiments of M. Graham Bell.—C. Cros.—Since light in passing from one medium to another of different density (separated from each other by a surface oblique to the direction of the rays), undergoes a deflection, we may infer that if the medium acts upon it, it must in turn act upon the medium. The author therefore affirms that:—(1.) Light tends to assimilate the density of the medium which it traverses to that of the medium whence it has issued. (2.) It tends to displace the transparent body in an opposite direction to the deviation which it undergoes. (3.) In case of reflection the reflecting body undergoes repulsion.

Distribution of Light in the Solar Spectrum.—J. Macé and W. Nicati.—In all cases the maximum intensity is in the yellow at a point very near to the ray D, in conformity with the generally received opinion. The intensity decreases very rapidly from this point on either hand, and becomes very feeble in the blue. The perception of the blue and the violet diminishes much more slowly with the decrease of illumination than does that of the less refrangible colours. From the extreme red to the green of the wave-length $0^{\mu}.5$, the law of the distribution of intensity remains absolutely the same, whatever may be the illumination. Even between eyes equally capable of distinguishing colours there are very sensible differences.

Vibratory Forms of the Circular Pellicles of Saposaccharic Liquid.—C. Decharme.—For the same diameter of a pellicle the numbers of nodals are inversely proportional to the corresponding lengths of the vibrating rod.

Place of Boron in the Series of Simple Bodies.—A. Etard.—Since boron was excluded from the carbon family by the researches of MM. Wœhler and Ste.-Claire Deville, it has not found its place in the classification of the elements. The author, founding his opinion on the atomicity of boron, which passes from 3 to 5 in the compounds BCl_3 and $BOCl_3$, assigns it to the phosphorus group. There will thus be the series N, P, As, Sb, B, &c., and B, Va, Nb, Ta, &c.

Propyl-acetal and Iso-butyl-acetal.—J. de Girard.—The author has obtained and analysed these two compounds.

Bulletin de la Société Chimique de Paris. No. 9, June 5, 1880.

Russian Chemical Society, Session of May 3/15, 1879.—M. Tougolessoff showed that the hydrocarbide $C_{10}H_{16}$ derived from diamylene is not identical with terebene.

MM. Boutlerow and Wischegradsky by causing alkalies to act upon cinchonine have obtained quinoline and a solid, which if again treated with acids is resolved into several acids and a volatile alkali.

M. Wischnegradsky described the results of his researches on the constitution of quinoline.

A paper was communicated on behalf of M. Krestownikoff, on the aldehyd of β-chloro-propionic acid.

M. Maretnikoff brought before the Society a memoir on β-chloro-butylic aldehyd.

MM. Narkownikoff and Krestownikoff communicated a paper on homo-itaconic acid.

M. O. Miller gave an account of the products of the dry distillation of calcium phthalate.

M. L. Chickoff described the result of his experiments on the constitution of milk. He considers it as an emulsion of fat in a special liquid formed of a mixture of albuminoid matters, sugar, &c. The emulsion requires the presence of a certain quantity of free fatty acids.

M. Tawildaroff has not succeeded in forming triethylglycerin by heating acrolein with absolute alcohol in presence of acetic acid.

MM. Beilstein and Jawein describe a new method of separating manganese and iron, based on the fact that, in the cold, iodine throws down all the manganese as peroxide from a solution of the two metals in an excess of potassium cyanide.

M. Wroblewsky proposes to separate orthoxylen from its isomers by means of its acetylic derivatives.

M. Maltschewsky read a note on the preparation and properties of aniline dithionate.

M. Sokoloff communicated analyses of the water of the Oka and of the springs which supply the town of Nijny Novgorod.

M. Tchelzoff sent a note on the determination of nitrogen in the explosive ethers of nitric acid.

M. Boutlerow described his researches on isotributylen.

MISCELLANEOUS.

Royal Institution of Great Britain.—The Lecture Arrangements (yet incomplete) for the ensuing Season (before Easter) will include the Chrismas Course by Prof. Dewar; and Courses by Profs. Tyndall and Schäfer, the Rev. William Haughton, the Rev. H. R. Haweis, Mr. H. H. Statham, Mr. Reginald S. Poole, and others. Friday Evening Discourses will probably be given by Mr. Warren De La Rue, Professor Tyndall, Sir John Lubbock, Sir William Thomson, Dr. J. Burdon Sanderson, Dr. Andrew Wilson, Dr. Arthur Schuster, Mr. Alexander Buchan, Dr. W. H. Stone, Dr. W. J. Russell.

Society of Arts.—The First Meeting of the One-Hundred-and-Twenty-Seventh Session of the Society is announced for the 17th November, when the Opening Address will be delivered by F. J. Bramwell, F.R.S., Chairman of the Council. Before Christmas there will be four Ordinary Meetings, in addition to the Opening Meeting, at which the following papers will be read:—November 24th—"Barry's Influence on English Art," by J. Comyns Carr. December 1st—"The Photophone," by W. H. Preece. December 8th—"London Fogs," by Dr. A. Carpenter. December 15th—"The Use of Sound for Signals," by E. Price Edwards. The following papers are down on the list for reading after Christmas:—"Buying and Selling: its Nature and its Tools," by Professor Bonamy Price; on this evening Lord Alfred S. Churchill will preside. "The Participation of Labour in the Profits of Enterprise," by Sedley Taylor, M.A., late Fellow of Trinity College, Cambridge. "The Gold Fields of India," by Hyde Clarke. "Flashing Signals for Light-houses," by Sir William Thomson, F.R.S. "The Present Condition of the Art of Wood-carving in England," by J. Hungerford Pollen. "Ten Years' Experience of the Working of the Trade Mark Act," by E. C. Johnson. "Trade Prospects," by Stephen Bourne. "The Manufacture of Aërated Waters," by T. P. Bruce Warren. "The Compound Air Engine," by Col. F. Beaumont, R.E. "Improvements in the Treament of Esparto for the Manufacture of Paper," by William Arnot, F.C.S. "Deep Sea Investigation, and the Apparatus used in it," by J. G. Buchanan. "The Discrimination and Artistic Use of Precious Stones," by Professor A. H. Church. "Indian Agriculture," by W. R. Robertson. Five Courses of Lectures are announced under the Cantor bequest:—First Course—Five Lectures on "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain," by Professor A. C. Church. Second Course—Three Lectures on "Watchmaking," by Edward Rigg, M.A. Third Course—Four Lectures on "The Scientific Principles involved in Electric Lighting," by Prof. W. G. Adams, F.R.S. Fourth Course—Three Lectures on "The Art of Lace-making," by Alan S. Cole. Fifth Course—Three Lectures on "Colour Blindness and its Influence upon Various Industries," by R. Brudenell Carter. The two Juvenile Lectures, for children of Members, during the Christmas Holidays, will be by G. J Romanes, F.R.S., on "Animal Intelligence." The arrangements for the "Indian," "Foreign and Colonial," and "Chemical and Physical" Sections will be announced after Christmas.

MEETINGS FOR THE WEEK.

Monday, 8th.—Royal Academy of Arts, 8. "The Action of Light, Heat, Moisture, and Air upon Oils, Turpentine, and Resins, by Arthur H. Church, M.A.
—— Royal Geographical, 8.30.
—— Medical, 8.30.

Tuesday, 9th.—Anthropological Institute, 8. "On Anthropological Colour-Phenomena in Belgium and elsewhere," by Dr. J. Beddoe. "On different Stages in the Development of the Art of Music in Prehistoric Times," by Mr. J. F. Rowbotham. "On Neolithic Implements in Russia," by Prince Paul Poutiatin.
—— Medical and Chirurgical, 8.30.
—— Civil Engineers, 8.
—— Photographic, 8.

Wednesday, 10.—Microscopical, 8.

Thursday, 11th.—Royal Academy of Arts, 8. "The Changes to which Painting Grounds are Liable," by Atrhur H. Church, M.A.
—— Mathematical, 8.

Friday, 12th.—Quekett, 8.
—— Clinical, 8.
—— Astronomical, 8

Saturday, 13th.—Physical, 3. "On the beats of Mistuned Consonances of the Form $h:1$," by R. H. M. Bosanquet. "Note on Prof. Exner's paper on Contact Electricity," by Profs. Ayrton and Perry "On Action at a Distance," by Walter R Browne.

MIDLAND RAILWAY.

CHEMICAL ANALYST WANTED.

The Directors of the above Company are prepared to receive applications from competent persons desirous of filling the above appointment. Salary to commence at £200 per annum. Applications with testimonials to be sent in addressed to the Secretary of the Locomotive Committee, Midland Railway, Derby, and must be received not later than 9.0 a.m. on Saturday, 27th November, 1880.

JAMES WILLIAMS, Secretary.

Derby, 3rd November, 1880.

MR. J. S. MERRY,

ASSAYER AND ANALYTICAL CHEMIST,

SWANSEA.

ROYAL POLYTECHNIC.—Asmodeus, the Bottle Imp. Ventriloquism and Magic, by Professor Hellis. Modern and Machine Guns, the New Forest, the Oxy-hydrogen Microscope, &c., by Mr. J. L. King. Musical Entertainment by the talented Adison family. Sights of London, by Mr. Heath. Blondin and Leotard, the marvellous Automata. Diving Bell, Moving Machinery and Models. The Royal Polytechnic Barometer, &c. Stokes on Memory, Tuesdays and Thursdays at 7. Open 12 till 5, and 7 till 10. Admission 1s.

MOTTERSHEAD & CO.,

7, Exchange Street and 10, Half Moon Street,

MANCHESTER.

CHEMICAL & PHYSICAL APPARATUS,

BOTTLES, PURE CHEMICALS,

REAGENTS, STANDARD SOLUTIONS,

And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

BETHESDA MINERAL SPRING,

WAUKESHA, WISCONSIN, U.S.A.

Invaluable in Diabetes, Bright's Disease, Urinary Diseases, Dyspepsia. A Mild Aperient. Sold by all Chemists and Mineral Water Agents. Agents wanted.

For special terms and further information apply to CEARNS and BROWN, 32, Chapel Street, Liverpool.

GREENBANK ALKALI WORKS COMPANY
(LIMITED),
ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{3}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

Carr's Patent Paint and Drug Mill.

Approved by some of the most eminent Chemists, and awarded the Silver Prize Medals of the Manchester and Liverpool, and the Middleton Agricultural Shows.

From Messrs. E. H. SMYTH & Co., 21, Duke Street, Edinburgh, and 69, Coleman Street, City, London.—The small Levigator Mill we recently got from you works most efficiently, and is a great economiser of time.

The chief feature in this machine is, that although it can be turned with ease by a boy, it has immense frictional power for levigating purposes. This is caused by the runner being driven at a much greater speed, but in the same direction, than the bowl. The surfaces being Minton ware, they are clean, smooth, and durable.

Testimonials on application.

£11 nett cash, delivered in Manchester.

The diameter of the bowl is 18 ins., and it and the runners are made of Minton ware. It is useful for Painters, Chemists, Grocers, and Cooks, for triturating and mixing Medicines, Vegetable Powders, Ointments, Paints, Sugar, Salt, Spices, Herbs, Meat for Potting, and will grind the COARSEST EMERY INTO A NEARLY IMPALPABLE POWDER in a few seconds. The pan can be tilted for emptying, as shown in the dotted lines; it can be worked by hand or power.

SOLE MAKERS—
W. H. BAILEY & Co., Albion Works, Salford, Manchester.

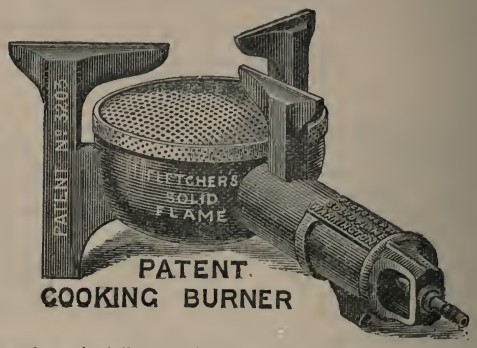
BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

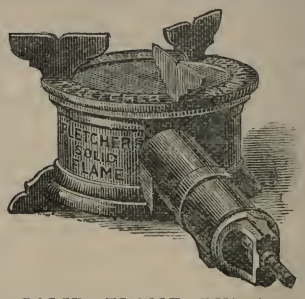
FLETCHER'S
PERFECTED SOLID FLAME GAS COOKING AND HEATING BURNER.
PATENTED AUGUST, 1880.

The only perfect Burner for Cooking, Boiling, and Dirty Laboratory Work. Free from smell, the most powerful Burner known, and not damaged by the roughest, dirtiest work. This Burner is a valuable improvement on Fletcher's well-known Solid Flame Burner, of which



thousands are in daily nse. The Gauze is done away with and replaced by a loose perforated Dome of Solid Copper, which can be taken off and cleaned when choked with dirt. The Stand is broad and firm, supporting large or small vessels safely and steadily.

PRICE, Japanned, 6s. 6d.; Nickel Plated, 8s. 6d



ORIGINAL SOLID FLAME BURNER, with Gauze, Price, Bronzed, 4s.; Nickel Plated, 5s.

All these Burners are the same power, and will with equal ease Boil an Egg, Cook a Chop, Boil a Kettle, or Melt half a hundredweight of Lead in an Iron Pot. They will Boil half a gallon of Water in a Flat Copper Kettle in Six Minutes, and work equally well with Air Gas or Coal Gas.

GAS FIRE.

An attachment to the above making a first-rate Gas Fire is in preparation. Complete Illustrated List, Price 3d., of Gas Furnaces for Crucibles, Muffles, Ladles, Porcelain, Painting, &c.; Hot and Cold Blast Blowpipes; Foot, Hand, and Automatic Blowers, Ingots Moulds, &c.; with reprint of Mr. Fletcher's Lecture to the Society of Arts on *The Application of Gaseous Fuel to Laboratary Work*, for which he was awarded the Society's Silver Medal in June, 1880.

THOS. FLETCHER,
4 & 6 MUSEUM STREET, WARRINGTON.

BISULPHIDE OF CARBON,
CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,
161, 162, 163, PALMERSTON BUILDINGS, LONDON, E.C.

THOMAS ADKINS & CO.,
SMETHWICK,
NEAR BIRMINGHAM

MANUFACTURERS OF SPECIALLY PREPARED RED LEAD FOR FLINT-GLASS MAKING.

THE CHEMICAL NEWS.

VOL. XLII. No. 1094.

THE CONSTITUTION OF AMIDO-, AZO-, AND DIAZO- COMPOUNDS.

By S. E. PHILLIPS.

(ABSTRACT.)

THERE are few departments of organic chemistry which possess a greater interest than the azo-colouring-matters, which have quite recently threatened to become an extended rival to the beautiful coal-tar colours. Their constitution has long been a puzzle, and modern attempts can scarcely be regarded as at all settled or satisfactory. We may note three main lines of thought, as devoted to their interpretation—all endorsing the modern delusion that tri-atomic nitrogen replaces three atoms of hydrogen as a common basis in these endeavours; it is also, and correctly, agreed that the initial or typical reaction is to be found in the action of nitrous acid upon aniline.

(1.) Hofmann's view is that "2 molecules of aniline are linked together, in which 3 atoms of H are replaced by 1 atom of N," yielding azo-diphenyl-diamine (in old notation), $C_{24}H_{14}N_2+HNO_4-4HO=C_{24}H_{11}N_3$.

(2.) P. Griess, regarding this body from a benzene rather than an aniline point of view, considers it to be a diamine combination of diazo-benzene and amido-benzene. That the reaction consists of 2 parts or stages is commonly known, seeing that we may so vary the reaction as to obtain either diazo-benzene by itself, or in combination with its menstrua, amido-benzene.

$$\left.\begin{matrix}\text{Diazo-benzene} = C_{12}H_5.(NH_2)HN \\ \text{Amido-benzene} = C_{12}H_5 \quad H \quad HN\end{matrix}\right\} = C_{24}H_{11}N_3.$$

By very many chemists it is called diazo-amido-benzene.

(3.) Dr. O. N. Witt, fully accepting the terms and ideas involved in the 1st reaction by which diazo-benzene is produced, yet strongly regards the 2nd stage as resulting in what he calls amido-azo-benzene.

Starting from the hypothetical body of double atomic weight he has—

$C_{12}H_3,H_2N$	=azo-benzene=	(*a*)
Aniline-yellow	=amido-azo-benzene=	(*b*)
Chrysoidine	=diamido-azo-benzene=	(*c*)
Phenylene-brown	=triamido-azo-benzene=	(*d*)

(*a*) $C_6H_5-N=N-C_6H_5 = C_{24}H_{10}N_2$.
(*b*) $C_6H_5-N=N-C_6H_4(NH_2) = C_{24}H_{11}N_3$.
(*c*) $C_6H_5-N=N-C_6H_3(NH_2)_2 = C_{24}H_{12}N_4$.
(*d*) $C_6H_4(NH_2)-N=N-C_6H_3(NH_2)_2 = C_{24}H_{13}N_5$.

Viewing these different initial terms and ideas, in connection with their interminable consequents in a very extended series of azo-colours, each preserving a certain numerical conformity to the facts of analysis, one may well feel a certain degree of humility in presuming to give another interpretation to such a complex field of chemical research.

It is, however, some consolation to find that upon viewing matters from the new or original point of view of old chemistry, and eschewing all modern hypotheses, that in an eclectic sense we find the views of Griess and Hofmann to be two isomeric sides of the probable truth.

This essay consists of two parts—1st, a wide endeavour to analyse the constituent elements, and to define the uncombined azo- and amido- bodies involved; and 2nd, to estimate upon old principles of ammonia condensation, apart from any new or special hypothesis, the modes of their combination to monamine, diamine, and triamine colouring bases.

Amides are defined as of two kinds—1st, the ordinary amides, so well understood by which hydrates with ammonia lose 2HO, while the *radical* replaces one H, in the ammonia type, reactions so familiar in the production of—

Ethylamide, C_4H_5, H_2N
Acetamide, $C_4H_3O_2,H_2N$, &c.

2nd, other amides, whose genesis is not so clearly understood, where the same materials lose 2H instead of 2HO, the radical becoming more oxidised in proportion.

	By 1st Reaction.	By 2nd Reaction.
Phenol gives	$C_{12}H_5,H_2N$	$C_{12}H_5O_2,H_2N$
Acetic acid gives	$C_4H_3O_2,H_2N$	$C_4H_3O_4,H_2N$, &c.

The modern view is that the 2nd series are acid bodies, with amidogen replacing one A of any given acid, and they are all notated with the supposed character of real acids, the notation ending in (COOH).

Acetic acid, $CH_2.H.COOH$
Amido-acetic acid, $CH_2(NH_2).COOH$, &c.

Our aim is to completely refute this interpretation, by a wide survey of the facts of their essentially amide or *basic* characters.

The alleged salts of these so-called acids are often referred to, but it is easy to prove that they are no salts at all, but metal replacements in the amido base. As well might we say that zinc amide is a salt, and that ammonia is its acid. It is painful to note how large a portion of modern chemistry is confused in this manner.

A complete refutation of the modern imido-theory is similarly attempted, and marvellous indeed it is to see how plain and simple facts can be distorted by special or wanton hypothesis. Tabular views of typical amido-bodies are given as thus where A=(NH_2).

Benzene, $C_{12}H_5,H$ (*a*) — Benzoic acid, $C_{14}H_5O_4,H$ (*b*)

	Amido.	Diamido.	Triamido.
(*a*)	$C_{12}H_5H_2N$	$C_{12}H_5AHN$	$C_{12}H_5AAN$
(*b*)	$C_{14}H_5O_4,H_2N$	$C_{14}H_5O_4,AHN$	$C_{14}H_5O_4,AAN$, &c.

It may be noticed that the ordinary amide of benzoic acid is $C_{14}H_5O_2$. An amide, or amido-body, is in every case a replacement of one H by amidogen.

An azo-body is in every case precisely the same thing, under a more reducing action, by which 2H of the radical are eliminated. This proposition is apparently true in the sense of a universal law, as upon a wide survey we have found no exceptions. Meanwhile a tabular view of some of the typical cases are given in comparison with their amido-analogues, as thus—

Benzene (*a*)	Phenol (*b*)	Benzoic acid (*c*)
Amido.	Azo.	Diazo.
(*a*) $C_{12}H_5,HN$	$C_{12}H_3,H_2N$	$C_{12}H_1AHN$
(*b*) $C_{12}H_5O_2,H_2N$	$C_{12}H_3O_2,H_2N$	$C_{12}H_1O_2,AHN$
(*c*) $C_{14}H_5O_4,H_2N$	$C_{14}H_3O_4,H_2N$	$C_{14}H_1O_4,AHN$, &c

A further list is briefly traced in their individual characters and histories, and the same principle is applied to both tri- and tetra-azo-bodies, with only one uniform result. All such amido- and azo-bodies can be traced as weakly amido- or ammonia-bases, in their varied saltic combinations, and, while the facts of analysis are quite independent of old or new modes of representation, it becomes an early enquiry of the second part, why most of these bodies should be found in modern manuals of double atomic weight. Two reasons for, or explanations of, this dire confusion are given as an introduction to the second part.

1. An *illogical* interpretation of the Avogadro Law.
2. A want of clear views in regard to the laws of ammoniacal dedoublement or condensation.

"If we can interpret the whole series, as embracing nothing new beyond the normal laws of condensation of the ammonia type, where our alphabet of the constituents, Part I., can be clearly and distinctly traced, not only in the compounds, but in the materials employed for their production, it will add a force and value to their appre-

hension, which no atomic doubling or molecular hypotheses can upset or destroy."

Here follows a brief chemical history of some of the principal compounds, including the monamine variety, where the fertile substance diazo-benzene combines with phenols, acids, and other hydrates, in modes and ways fully made plain in the previous history of chemical research.

Of the diamine series, we only refer to chrysoidine in this connection, as we have given it a position in Dr. Witt's initial series, where a numerical regularity might captivate attention. However plausible on paper, it has the misfortune of being like melid-acetic acid, which had no acetic acid in its genetic materials, and is no acid at all, being a definite glycolyl-melamine base; so in the case of chrysoidine there is no azo-benzene, whatever in its genetic materials, and every chemist must know that as aniline-yellow is or may be formed *directly* by combining diazo-benzene with amido-benzene, precisely so it is with chrysoidine, where the amido- body is replaced by diamido-benzene. The Griess view of the chrysoidine triplet is therefore thus—

Aniline-yellow = Diazo- (and) amido-benzene, (*a*)
Chrysoidine = Diazo- (and) diamido-benzene, (*b*)
Phenylene-brown = Diazo- (and) triamido-benzene, (*c*)

$$(a)\quad \left.\begin{matrix} C_{12}H_7AHN \\ C_{12}H_5HHN \end{matrix}\right\} = C_{24}H_{11}N_3.$$

$$(b)\quad \left.\begin{matrix} C_{12}H_7AHN \\ C_{12}H_5AHN \end{matrix}\right\} = C_{24}H_{12}N_4.$$

$$(c)\quad \left.\begin{matrix} C_{12}H_7AHN \\ C_{12}H_5AAN \end{matrix}\right\} = C_{24}H_{13}N_5.$$

It only remains to say that any student who may wish to canvass broad views on this aspect of chemical philosophy will be quite welcome to a perusal of the paper now so briefly abstracted.

16, Greenwood Terrace, St. John's, Hackney.

HEATING BY GAS.*

Cooking in Private Families, and use in Workshops.

By THOS. FLETCHER, F.C.S.

It is not my intention to-night to go deeply into the theory of gaseous fuel; to do so would take more time than is at my disposal. The figures I shall give are approximately correct, quite sufficiently so as a guide to consumers. Unfortunately I am not in a position to give the practical working values of the gas of high illuminating power as used in Scotland; my knowledge of this comes to me from others, and from what I can learn it would appear to be about one-sixth worse as a fuel than the same quantity of London gas. This is not owing to its actual inferiority, but is caused simply by the greater difficulty in burning so as to obtain a compact flame of high temperature, such as is necessary for an economical gaseous fuel; and without setting up my opinion as absolutely reliable, in the absence of sufficient practical experience, I think that as gas is now so largely used as a fuel, the Scotch gas companies would find it to their advantage to reduce their quality to the average English standard, reducing the price also in proportion. At present it is like a break in a railway gauge, and causes endless trouble and annoyance to both makers and users of gas apparatus for heating purposes, checking most seriously the consumption of gas in Scotland, and doing considerable damage to the gas companies; the gas used for heating being almost entirely wanted when the gas works are at present almost standing idle, *i.e.*, in the day time, and in summer more than winter. The gas companies who do not seriously consider the advisability of taking every possible means to increase the consumption of gas for heating purposes are simply ignoring their most important business and neglecting their most valuable and profitable customers. I would even go beyond this, and make for all purposes a gas of about 14 candle power as a maximum, and sell it, as it very well could be sold, at about 1s. 10d. per 1000 cubic feet (which, by the way, I am informed is the present price in Leeds). This would be cheap, perfectly suited for all purposes, both lighting and heating, and would be very much more largely used than the present gas. If the gas companies have any great future to look to it is from the use of gas for heating purposes, which can be cheaply made in large quantities at a time when the works are almost standing idle. Those who objected to the little additional heat given off from the lighting burners could well afford the expense of ventilating out of the reduction in their bills, and both makers and consumers would be benefited. At present the use of gas as a fuel is hampered in every way by the sleepy let-well-alone system of manufacturers with a monopoly, having their customers under their thumbs. The only reply I ever obtained to any remarks about creating a business in gas for cooking is "Ah, we are doing very well; look at our profits last year." These profits, bear in mind, are the result of excessive prices, in the face of a wasteful and costly system of working. If the Crystal Palace Gas Company understand their business, and we may suppose they do, it is the business of a gas company to test and know all the cooking and heating apparatus, to judge and select for their customers, knowing positively the best, and to fix the apparatus on hire, as they do gas meters, at a low rate, publishing and distributing constantly pamphlets explaining the advantages of gas heating and also its disadvantages, giving the whole case honestly and fairly. The united gas companies could afford well to offer a high premium for the best and most concise pamphlet on gas cooking, and to print and distribute it by the million. It is their duty to do so, and they would combine both duty and profit. It is not the business of any maker of gas cooking and heating apparatus, who naturally states his own side of the case and kindly overlooks all his weak points, even if he knows them.

In England a mixture of about 75 per cent cannel and 25 per cent good coal is commonly used for gas making. This produces from each ton 13 cwts. coke, 13 gallons tar, 25 gallons ammonia liquor, and 10,000 cubic feet of gas of about 18 candle power. The gas, if reduced to the solid state again, would weigh about 350 lbs. Allowing this as a fuel at a value of 1s. 2d. per cwt., which is about the average cost of the material used to produce it, we get the actual fuel value of coal gas as about 4¼d. per 1000 cubic feet. Its cost at the gas works, delivered into the mains, including all expenses, is about 1s. 2d. per 1000 cubic feet.

Gasoline, benzoline, and petroleum, which are all hydrocarbons, and very similar in composition to coal gas, may be taken as fuel as equal to coal gas in value. A little calculation shows them to be worth as fuel about 10½d. per gallon, coal gas being 3s. 6d. per 1000 cubic feet—one gallon being equal to about 250 feet of gas. To get this duty from the petroleums it is necessary that they shall be burnt in a state of vapour. When burnt in spray or as a simple flame in a lamp with a wick it is exceedingly difficult in practice to obtain a fair proportion of the work out of them, and they become very expensive. When burnt as vapour, such as is produced from benzoline or gasoline in any of the well-known air gas apparatus, or in the simple little generator I will show you at the conclusion, there is no practical difference between the cost of these and of coal gas as fuel, and my remarks will apply in almost every point equally to coal gas, and the vapour or air gas made by passing air through gasoline or spirit petroleum. The generator which I shall use at the conclusion is simply a tin box divided lengthways, so as to secure a long passage for the air through a number of cotton screens, saturated with spirit petroleum. If I use

* A Paper read before the Philosophical Society of Glasgow, October 22, 1880.

the more volatile gasoline instead of spirit petroleum the supply of vapour from a generator of about 1 cubic foot capacity, is equal to a coal gas supply through a 1¼ or 1½ inch main at ordinary pressures, and will work two of my largest furnaces—each melting 28 lbs. of steel—at the same time. This generator, being specially designed for blast furnaces, has no blowing apparatus, and is therefore unfit for use except where a supply of air under pressure is available.

It will be at once seen that gas and petroleum, at present prices, can never approach coal or coke as a competitor for large or continuous work where the cheaper fuel can be burnt without great waste. When, however, we come to the cooking for private families, and almost the whole of the heating work required in small workshops, the conditions are completely altered, and gas fairly used becomes a very economical fuel.

Take as an example our own cooking for a family of eleven. The cooking each morning is done in about 10 to 15 minutes, frequently in less than 10 minutes. The dinner, including roast joint, pastry, two or three different vegetables, sauces, &c., requires one burner only for 1½ hours, and three others from 10 to 30 minutes, say an average of 30 minutes for four burners. Tea and supper may be taken at a maximum of 10 minutes each. We here have about an hour during which the burners are in use, at a total cost of about twopence per day; if we had a fire it would probably be burning 15 or 16 hours, burning almost the whole time many times more fuel than would be necessary to do treble the work required.

The same remark applies to general workshop use. To braze a joint a fire has to be kept going the whole day, or a man has to spend perhaps 20 minutes lighting a forge, whereas with gas he could do his work in two minutes. If 3 lbs. or 4 lbs. of metal is required for a casting, a large fire has to be lighted, burning probably 20 lbs. of coke and requiring one or two hours before the crucible can be put in. After melting, the fire has to burn itself out. With gas the metal can be melted in 10 to 15 minutes, with a consumption of about eight or nine cubic feet of gas, the actual cost of fuel being far less than coke, and the value of the workman's time saved being more than ten times the cost of both coke and gas put together. In a foundry where pots are in the furnaces all day gas would be, as compared with coke, excessively costly; and in cooking for large hotels and institutions, where the work is almost continuous and on a large scale, gas is far too costly a fuel for the bulk of the work; but both in the hotel and in the large workshop or foundry, gas, although not the main fuel, is most valuable, and in many cases absolutely necessary as an assistant.

To have gas fuel at command is to be always the master of the situation, as it is ready for instant use when the fires are out of condition or extinguished, and hardly a day passes when gas in both places would not be a cheap fuel for some purposes.

In my lecture before the Society of Arts I stated that I obtained in a perfectly arranged water heater one gallon of boiling water by the consumption of about 1½ cubic feet of gas. This statement has been pretty severely handled by the theorists who are supposed to know all about it. They say it is above the theoretical maximum possible. I find no error in my results after repeated experiments, and there are possible reasons why the practical maximum may exceed the present theoretical maximum, which would explain the difference in results. If the theorists would put their aprons on and work with their hands as well as their heads it would be better for both theory and practice, and the "practical maximum" of use the theorists are at present would be considerably increased.

I am frequently asked, "Is gas a cheap fuel as compared with coal?" This is not easy to answer. For family cooking it is, I think, rather cheaper than coal. In saving of work and time in cleaning and attention it pays for itself in most cases ten times over. I know in our own case the absence of gas for cooking would entail our having an extra servant, and a greatly increased wear and tear caused by the dirt and mess of fires. In the routine work of my own laboratory the absence of gas for odd work would entail an additional expense in wages of nearly 50 per cent, but in addition to this, my special work, which in fact has created all the gas apparatus I have ever devised, could not be carried on at all without gaseous fuel. I refer to the production of some special alloys of the rarer metals which can only be produced with certainty under the most exact conditions of temperature and time. For my own work all furnaces and burners must be as exact in results as a chemical balance, and must be under the most perfect and instantaneous control; they are, in fact, instruments of precision working with the certainty of a chronometer. Here we have a business of some importance, the very existence of the good reputation of which is absolutely dependent on gaseous fuel.

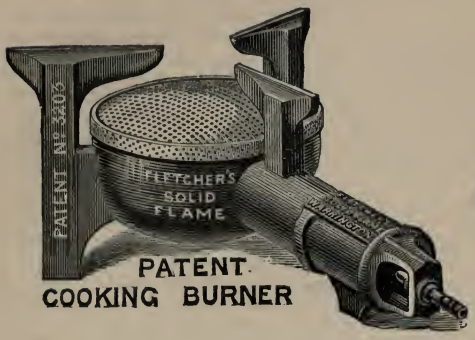
For cooking in ordinary families, for workshops where soldering, brazing, melting small quantities of metals in crucibles, &c., are required, and as an accessory in larger workshops, hotels, and public institutions, I consider gas fuel an absolute necessity for convenience and economy. It cannot be approached by any other fuel known. At the same time we must not forget that on account of its cost we cannot afford to waste it by using imperfect apparatus, and it pays better to throw away a faulty burner than to attempt to continue its use and make shift with it.

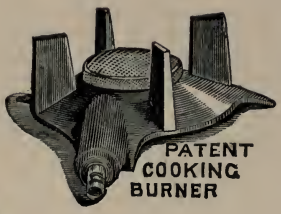
The question of the possibility of a good gas fire is frequently raised. I know many cases where gas fires have been fixed, and I know none where they have remained in use twelve months. They are far too costly in fuel, and I do not see how a good gas fire is to be made at a cost of less than 1d. to 1½d. per hour. Of course a small poor fire can be made for less, but it is practically useless, even to look at. If a gas fire is to be used I have no possible doubt that the proper material to be heated is most certainly not asbestos or fire-clay, but loose open balls of iron wire. It burns away slowly, but is very easy and cheap to replace, and gives off far more radiated heat than any substance I have yet met with, although iron is one of the worst radiators of heat known. The reason of this is simply that iron takes up heat much more rapidly than asbestos or fireclay, and becomes very much hotter.

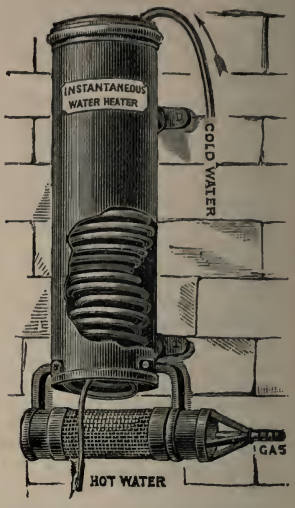
With regard to gas stoves, and giving my own personal opinion, the old style, be they reflectors or non-reflectors, are a horrible abomination, not to be tolerated by anyone whose nose and feelings are in anything like working order. I have a stove in use which is really a boiler with hot water pipes heated by gas, and which I shall again refer to; but the convected heat from warm metal, whatever the temperature of the metal, is to me so decidedly disagreeable, that it would be only a matter of pure necessity that would make me bear the annoyance. Still, speaking of my own feelings I greatly prefer, both for comfort and economy, to heat any room by gas by keeping the ordinary lighting burners at work without a glass globe. The radiated heat from these is, to myself, beyond comparison preferable to the convected heat from a surface of warm metal. You will clearly understand I speak now only for myself and my own feelings, having a strong dislike to any and every stove for gas or solid fuel, and also to the system of heating by hot water pipes when it can be avoided.

I have here a new form of oven for gas cooking, which so far as our own experience goes, is apparently destined to rule the pattern and principle of the gas ovens of the future. Using a line of solid flame so as to distribute the heat equally, the bottom of the oven is first heated. The whole of the radiated heat from the bottom is used underneath for toasting bread, grilling chops and steaks, making Yorkshire puddings, roasting potatoes, apples, &c. The hot air is then, after doing its work underneath, passed in a layer round the sides of the oven inside in such a manner that the products of combustion, although inside the oven, pass up round the sides and under the top so as not to come

APPARATUS USED TO ILLUSTRATE THE LECTURE.

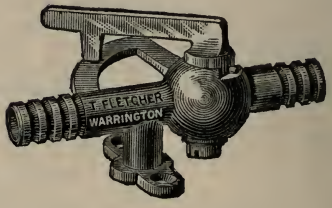




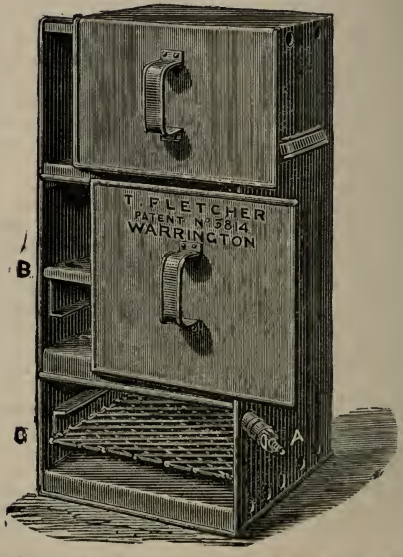


Instantaneous Water Heater, for Scullery and Bath-room.

Crucible Furnace for Gas or Petroleum Vapour, showing Gas-making attachment in use.



Boiling Bench.



Triple Oven, requiring only one Gas Burner.

into contact with the food. Here meat can be roasted, not baked, to perfection, also pastry, bread, and all cooking which requires browning and a dry sharp heat with plenty of ventilation. After doing its work here the heat is again taken into an upper oven in a precisely similar manner, but has become rather too moist to brown and roast well. This upper oven is specially adapted for rice puddings, stews, and work of this class. On the top of the oven, and also round the sides, plates and dishes can be warmed.

With the assistance of burners for boiling, this oven, which is about as simple and cheap in form as an oven well could be, will do in the most perfect manner everything which can possibly be done with a first-rate open fire range, and as it is fully hot in half a minute after lighting the gas, and therefore always ready for anything and everything at half a minute's notice, it overcomes the one great objection to a fire range. The one I show you, which measures 14 by 12 inches on the bottom, and costs on an average one penny for three hours' work, will do the whole of the cooking, boiling excepted, for a family of 12 or 14 people.

There is one purpose for which gas is frequently required, the heating of small greenhouses. The fumes of gas, burnt or unburnt, are seriously injurious to plants. My own tropical stove and orchid house is a very small one, too small to heat steadily with coke, and I have in it 40 ft. of 4½ inch pipe heated by gas. The burner is placed in a boiler inside the house, but is lighted from the outside, and the flue runs inside the water pipes for a distance of 20 ft. The products of combustion leave the house over the lighting hole at a temperature of from 75° to 85°. The house is well built and well glazed. To keep a minimum temperature of 60° in the summer and 50° in the winter costs about £10 per annum. To keep a minimum of 40° would cost about 25s. This is a further proof of the heavy cost of continuous work with gas; at the same time I could not do the same work with any other fuel, as the house is separate, and cannot be heated from the other boiler which is worked with coal, and which does ten times the work at a smaller cost. With gas it may be taken as an average that a rise of one degree in temperature costs about one penny for twenty-four hours in a plant house 12ft. square 12ft. high.

I will now proceed with my experiments and will show you the fusion of cast-iron in a crucible which, starting all cold, will require seven or eight minutes. I will then replace the crucible with one containing pure nickel, which I will melt in about 25 minutes. I may say that the fusion of pure nickel is a feat rarely attempted, and still more rarely successful in any furnace except the injector which I shall use. For the sake of rapid working I will only melt about half a pound in a small crucible. The heat required is so tremendous and the loss by radiation is so rapid the instant the crucible is removed from the furnace that I doubt whether I shall be able to pour it before it sets hard in the crucible, and I dare not exceed the heat required to melt the nickel, as no crucible will stand a higher temperature. If I fail to pour it I will cool the crucible and show you the fused mass, which you will see me put in the crucibles as small lumps. The lumps I use have been fused and poured in a larger bulk in a furnace precisely similar to the one I use, but of a larger size. Whilst these rather noisy operations are going on I will show you the difference between a solid and a hollow flame, both having the same appearance, by putting my bare finger in the centre of the hollow flame, my hand being protected from the outer film of flame by a wet cloth. I will then put a ball of gun-cotton in the centre of the hollow flame, and afterwards explode it by making the flame solid.

I asked my wife to be my head cook for to-night, intending to give you a practical illustration of cooking on a variety of substances; but she refused, and as you see here I am, the unhappy victim of a monopoly, as she, like the gas companies, has no fear of opposition and does as she likes. We must, therefore, omit our intended extensive supper: I offer no apologies; we are all present the victims of this monopoly, and we must make the best of it. To assert my independence I will, however, roast you a small joint, bake a fruit pie, and cook a fish underneath, so that the vapours from the fish will have to pass completely round both the roasting meat and the pie. If the fish flavours either, no doubt someone present will be sharp enough to discover it.

I wished to show you the actual working of a four-course dinner for twelve people, *i.e.*, soup with dry toast, fish, joint with three vegetables, sauces, pastry, custards, &c.; warming about 50 plates and dishes, and boiling three or four gallons of water for washing up, all of which we can easily do with the oven and three small boiling burners now before you. When I was a bachelor, and before I came under petticoat government, I never dreamt of such a thing as a four or five-course dinner, more especially when, as often happened, I had to cook it myself; there is no telling what one may come to when somebody else has to do the cooking.

ON THE PRESENCE OF COPPER IN SULPHATE OF SODA CRYSTALS.

By Dr. PHIPSON.

THE coarse sulphate of soda crystals obtained, from tanks where copper is extracted by the wet process in Cornwall, have given me, besides a very large amount of chloride of sodium and much iron,—

Oxide of copper	0·62
Oxide of lead	0·15
Tungstic acid	0·10
Silver	trace
Arsenic	trace

The comparatively large amount of copper in these crystals is worthy of notice.

ON THE PRESENCE OF NICKEL IN CORNISH MANGANESE.

By Dr. PHIPSON

SOME splendid specimens of Cornish oxide of manganese have yielded me notable amounts of oxide of nickel with little or no cobalt. Upwards of 0·1 per cent metallic nickel was obtained in two analyses, with a mere trace of cobalt.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 4, 1880.

Prof. H. E. ROSCOE, President, in the Chair.

THE following certificates were read for the first time:—J. O. Arnold, A. E. Barclay, A. C. Cockburn, P. H. Cathcart, T. Farrington, P. F. Frankland, A. E. Garrod, R. Holliday, A. Jesseman, J. A. Macfarlane, W. B. Mason, R. T. Plimpton, C. H. Sharples, F. M. Sexton, B. H. Thwaite, J. M. Wyborn.

The PRESIDENT congratulated the Society on having thirteen papers down for reading on the first evening of the session.

During the reading of the first paper, which was com-

municated by the President, Dr. FRANKLAND took the Chair.

"*On the Sulphides of Vanadium*," by W. E. KAY. Berzelius describes in his original research on vanadium two sulphides, VS_2 and VS_3; from the researches of Roscoe it follows that their real formulæ should be $(V_2O_2)S_2$ and $(V_2O_2)S_3$. The author has repeated the experiments of Berzelius, analysed the compounds formed, aad investigated the whole subject. He also gives details of the method employed to estimate the sulphur, *i.e.*, ignition in a hard glass tube in a stream of oxygen, the products of combustion passing successively through two Liebig's potash bulbs, the first filled with bromine water, the second with distilled water. Berzelius obtained his compounds by precipitation, and, one of them, by a dry process. The substances formed in the wet way are oxy-compounds, but do not seem to have any definite composition. The dry process, *i.e.*, heating V_2O_3 to redness in sulphuretted hydrogen, forms, curiously enough, V_2S_3, which gives the same increase in weight over that of the V_2O_3, as $(V_2O_2)S_2$; so that if Berzelius had but estimated the sulphur in the product instead of being satisfied with the increase of weight, the true constitution of the vanadium compounds would probably have been ascertained by him. The author has obtained and studied three sulphides, V_2S_2, V_2S_3, and V_2S_5. V_2S_2 is obtained by reducing V_2S_3 in a current of hydrogen, as glistening black scales, or a blackish powder; it absorbs oxygen with avidity. Hot strong sulphuric acid gives a greenish yellow solution; hot strong nitric acid oxidises it with violence; colourless ammonium sulphide gives a splendid purple solution; it is acted upon but slightly by caustic alkalies. V_2S_3 is prepared as above, or by the action of SH_2 or CS_2 at a red heat on V_2O_5. In its properties it resembles V_2S_3, but is oxidised less readily. V_2S_5 is prepared by heating a mixture of S and V_2S_3 in a sealed tube to 400° for three hours; it resembles the other sulphides, but is readily dissolved by caustic soda. The author remarks the inferior stability of the sulphides as compared with the oxides, V_2S_5 when heated giving off sulphur and forming V_2S_3, whilst V_2S_3 in an atmosphere of hydrogen is reduced to V_2S_2.

"*On the Action of Zinc Ethyl on Benzoylic Cyanide*," by E. FRANKLAND and D. A. LOUIS. The cyanide was gradually added to zinc ethyl diluted with three times its volume of dry ether, and the reaction completed by heating in a water-bath. The product of the reaction, an amber-coloured jelly, was decomposed, and then extracted with alcohol. Tufts of colourless needles were obtained which gave on analysis $C_{24}H_{19}NO_2$. The authors propose the name benzcyanidin; the yield is small, about 3 per cent of the cyanide. Another substance boiling between 200° and 220° was obtained, but the authors did not succeed in purifying it so as to procure a liquid with a constant boiling-point. It was oxidised with bichromate and dilute sulphuric acid, when propiophenone, $C_9H_{10}O$, was obtained, which the authors believe was formed directly by the action of zinc ethyl on the benzoylic cyanide—

$$2\begin{Bmatrix} C_6H_5 \\ CO(CN) \end{Bmatrix} + ZnEt_2 = 2\begin{Bmatrix} C_6H_5 \\ COEt \end{Bmatrix} + Zn(CN)_2.$$

Much zinc cyanide was also formed. The halogen nature of the compound radical cyanogen is thus shown to extend to its replacement by an electro-positive hydrocarbon radical.

"*On the Action of Zinc Ethyl on Cyanogen*," by E. FRANKLAND and C. C. GRAHAM. The zinc ethyl rapidly absorbs the cyanogen, and is finally converted into a solid mass. This mass was heated to 120° in an oil bath, and furnished a colourless liquid, which was freed from traces of zinc ethyl and re-distilled. It then boiled at 96°; analysis indicated the formula C_3H_5N, and it had all the properties of propionitrile. The solid residue remaining after the distillation, consisted almost entirely of zincic cyanide. The reaction is therefore—

$$2\begin{Bmatrix} CN \\ CN \end{Bmatrix} + ZnEt_2 = 2Et(CN) + Zn(CN)_2.$$

It is to be noted that a separation of carbon from carbon occurs, accompanied by a simultaneous union of carbon to carbon.

"*Report on the Atmospheric Oxidation of Phosphorus, and some Reactions of Ozone and Peroxide of Hydrogen*," by C. T. KINGZETT. The author commenced with a historical *résumé* of previous researches by Schönbein, Andrews, Marignac, Corne, Boehe, Leeds, McLeod, and himself. The author in the present research employed a series of glass bottles stoppered, each fitted with two glass tubes ground into holes in the stopper, thus avoiding altogether the use of cork and india-rubber. He concludes that both ozone and peroxide of hydrogen are produced by the oxidation of phosphorus, the peroxide of hydrogen remaining almost entirely in the water in which the phosphorus is oxidised. The ozone passes on in the air current, and after washing and drying with strong H_2SO_4, was estimated by the amount of iodine liberated in an acidified solution of potassium iodide. A large number of experiments were made. In several cases the proportion of peroxide of hydrogen to the ozone produced was approximately 1 to 2. The ozone was entirely destroyed at 240°, and by passing through oil of turpentine; it was, however, not destroyed by passing through a ten-volume solution of hydric peroxide. Ozone when it acts on oil of turpentine gives rise to the same peroxidised compound as is formed by the absorption of oxygen. The turpentine which has absorbed ozone, when treated with water, produces an equivalent amount of peroxide of hydrogen. Similar observations are recorded with ether. As regards the estimation of peroxide of hydrogen, the author finds that the ordinary process with potassic iodide and starch may be much shortened by employing a large excess of dilute sulphuric acid. When it is estimated by the amount of oxygen evolved with potassium permanganate, the author advises that no acid be added, as a mixture of potassic permanganate and sulphuric acid gradually gives off oxygen until all the permanganate is decomposed.

After a few remarks from the President and Dr. Armstrong,

The SECRETARY read a paper "*On Bismuth and Bismuth Compounds*," by M. M. P. MUIR, G. BERNARD HOFFMEISTER, and C. E. ROBBS. The preparation of the various oxides, hydrates, and halogen salts is discussed; previous work is criticised and experimentally examined. The oxides and hydrates certainly known to exist are Bi_2O_2, Bi_2O_3, Bi_2O_4, Bi_2O_5, $Bi_2O_3H_2O$, $Bi_2O_3,2H_2O$ and $3H_2O$, $Bi_2O_4H_2O$ and $2H_2O$, $Bi_2O_5H_2O$, and possibly $Bi_2O_2H_2O$ and $2H_2O$, and $Bi_2O_53H_2O$. The relative stabilities towards heat and reducing agents of the oxides, and towards heat of the hydrates, are discussed. The action of chlorine and bromine on the oxides is described. The hydration of the oxides in moist air is measured: $Bi_2O_32H_2O$ is shown to be the hydrate into which the others tend to pass. BiI_2 is much more stable, and more indifferent to reagents, than the corresponding bromide or chloride. There is apparently no tendency to form complex oxy-iodides. By the action of HF on Bi_2O_3, BiF_3 and BiOF are formed. The following equations represent the final distribution of salts in each reaction:—

$$\begin{cases} 1.\ Bi_2O_3 + 2HCl + xH_2O = 2BiOCl + (x+1)H_2O. \\ 2.\ Bi_2O_3 + 6HI + xH_2O = 2BiI_3 + (x+3)H_2O. \end{cases}$$

$$\begin{cases} 1.\ 3BiOCl + xHI + x'H_2O = \\ \qquad 2BiI_3 + BiCl_3 + (x-6)HI + (x'+3)H_2O. \\ 2.\ 4BiOI + xHCl + x'H_2O = \\ \qquad 3BiCl_3 + BiI_3 + (x'+4)H_2O + HI + (x-9)HCl. \end{cases}$$

An attempt is made to condense the leading relations between oxides and hydrates in structural formulæ, in all of which the bismuth atom is represented as trivalent.

"*On the Colour, Properties, and Relations of the Metals Copper, Nickel, Cobalt, Iron, Manganese, and Chromium*," by T. BAYLEY. These metals form a group of elements with atomic weights progressing from 52·2 to 63·00. They are characterised by salts, corresponding to their normal

oxides, which in dilute solution possess strongly-developed and characteristic colours. Standard solutions were prepared containing 5 grms. of each metal per litre. The iron was oxidised with nitric acid after solution in dilute sulphuric acid; the other solutions contained excess of both of these acids. By mixing 20 parts of the copper solution, 7 of the iron, and 6 of the cobalt, a colourless liquid was obtained, appearing, however, slightly grey from the partial suppression of the white light passing through; the colour equivalents of cobalt, iron, and copper are therefore respectively 20, 7, and 6, the colour equivalents being the numbers expressing the quantities of the metals required to produce an optically neutral mixture. The colour coefficients are the reciprocals of the colour equivalents reduced to terms of the coefficient of copper as unity. The colour coefficient expresses the specific chromatic power of the element in the particular combination. These numbers vary slightly with the temperature: thus, the above neutral solution (at 18°) when boiled appears to be yellow. By mixing iron and copper we can simulate exactly a nickel solution. A copper solution is complementary to a mixture of iron and cobalt, and to the reflection from a surface of copper. The mean wave-length of the light absorbed by iron, nickel, cobalt, and copper increases as the atomic weight increases. The mean wave-lengths of the light absorbed by nickel and cobalt are nearly identical. Generally the affinity of the metals of this group for oxygen increases with the colour coefficients. The coefficients are—Cu, 1; Ni, 1·05; Fe, 2·85; Co, 3·33; Cr, (?); Mn, (?). The oxides studied are the so-called normal oxides, *i.e.*, neither protoxides nor peroxides. The following table exhibits the colour properties of these elements as studied up to the present time, elements with solutions of similar colour being placed in the same colour:—

Yellow.	Orange.	Pinkish Red.	Violet.	Blue.	Green.
Fe	7Fe+6CO	Co	20Cu+6CO	Cu	20Cu+7Fe
Mn (?)	Copper reflection	Cr	Cr mixtures	Cr	Cr
	Mn (nearly)	Mn			(Ni nearly)

The following combinations give grey, partially opaque, liquids:—Cobalt, iron, and copper, copper solutions and copper reflections, chromium (blue) and copper reflection; copper, iron, and chromium (red); copper, iron, and manganese (red): chromium (green) and chromium (red); chromium (green) and cobalt. The author has specially examined only the first of these combinations. He gives diagrams showing the absorption-spectra of cobalt, copper, and iron, the solutions being of equivalent chromatic strength, *i.e.*, equal volumes give when mixed a grey liquid.

"*On the Action of Diazo-naphthalene upon Salicylic Acid*," by P. F. Frankland. Although numerous azo-bodies have been prepared, yet only a few thereof are compounds of the oxy-benzoic acids, and in none has the position of the phenyl-azo group been ascertained. The author's object was therefore twofold—the preparation of a new azo compound and the determination of the place of entry into the diazo group into the benzene nucleus of salicylic acid. The diazo group was introduced in the form of diazo-naphthalen, naphthyl-azo-salicylic acid being formed. This substance, on treatment with tin and hydrochloric acid, yielded naphthylamin and amido-salicylic acid. The latter was then converted by means of its diazo compound into iod-salicylic acid, which by its melting-point, reactions, and conversion into oxy-salicylic (quinol-carboxylic) acid, proved to be the iod-salicylic acid already known. The diazo group of the diazo-naphthalin thus attached itself to the benzene ring of the salicylic acid in the para position to the hydroxyl, and in the meta position to the oxatyl. In the preparation of naphthyl-azo-salicylic acid an amorphous brown body was obtained, insoluble in water. This proved to be a mixture of two substances—one soluble in alkalies, with the formula $C_{10}H_8NO$, the other insoluble in alkalies, $C_{30}H_{33}N_5O_2$.

"*On the Basic Sulphates of Iron*," by Spencer Pickering. The author has investigated the numerous sulphates said to exist, but of the existence of fifteen of them he can find no proof, there being apparently but one definite chemical compound.

"*Fourth Report to the Chemical Society on some points in Chemical Dynamics*," by C. R. A. Wright, E. H. Rennie, and A. E. Menke. The authors have determined the rate at which reduction of certain metallic oxides is effected under conditions varying as to temperature, but otherwise constant, with the view of finding out how far abrupt alterations in the rate occur when a higher is reduced to a lower oxide, the heat of formation of which differs from that of the higher oxide. They show that these alterations are readily distinguishable at any rate at certain temperatures. Thus, samples of ferric oxide in different states of physical aggregation were reduced under constant conditions by hydrogen and by carbon oxide: curves were then plotted, the amounts of reduction being taken as ordinates and the times as abscissæ. It was seen that as soon as one-ninth of the oxygen had been removed (so that the partially reduced oxide had the composition Fe_3O_4) a marked slackening in the rate of reduction was always observed, particularly at lower temperatures, a sort of angle being thus produced in the curve. No such angle exists at points representing either removal of one-third of the oxygen (reduction to FeO) or any other stage of reduction. The results with carbon oxide are complicated by its tendency to bring about re-oxidation,

$$Fe_xO_y + CO = Fe_xO_{y+1} + C.$$

The effect of this is to diminish the rate of reduction, nevertheless it was found almost invariably that the rate of reduction of carbon oxide was, *cæteris paribus*, greater than that of hydrogen, as was expected from the greater evolution of heat in the former case. Manganese dioxide was examined in the same way, with similar results: a distinct angle was exhibited by the curve when the composition was Mn_3O_4, and another angle when it was MnO. The reducing action of both hydrogen and carbon oxide then ceases up to a bright red heat. In every case the angle indicates a decrease in the rate of reduction, and that consequently the heat of formation of the lower oxide is greater than that of the higher oxide. From the present and previous experiments the authors deduce the general law that two comparable cases of reduction, in which the heat evolutions differ from another, the case in which the heat evolution is algebraically the greatest (*i.e.*, the greatest evolution or least absorption) is the case in which (*a*) the length of time requisite to produce a given amount of reduction at a given temperature, is the least, (*b*) the amount of reduction produced in a given time at a given temperature is the greatest, and (*c*) the temperature requisite to produce a given amount of reduction in a given time is the lowest. Certain apparent minor exceptions to this law have been noticed, and are explained by the non-identity of conditions, *e.g.*, when carbon oxide reduces ferric oxide, the action is retarded by the tendency, above alluded to, of carbon deposition; and, again, when the oxide is coated with a film of reduced substance the carbon oxide diffuses much more slowly than hydrogen under similar circumstances, the reducing action of carbon oxide being thus much retarded. Again, when metallic copper is oxidised a similar retardation takes place, owing to the formation of a film of oxide. The general law stated above may be represented graphically by constructing curved surfaces about three rectangular axes, the co-ordinates of any point on a surface representing time, temperature, and amount of reduction, the surface representing the values obtained with the substance, the reduction of which is accompanied by the greatest heat evolution, always lies outside.

"*On some Derivatives of Naphthalene* (1. *On β-naphthol Sulphonic Acid.*)," by H. E. Armstrong and W. C. Graham. The authors were led on certain theoretical grounds to re-examine the β-naphthol sulphonic acids pre-

pared respectively from β-naphthol, and from the so-called naphthalene, β-disulphonic acid, by fusion with caustic potash. They have prepared and examined various salts, and conclude that Ebert and Merz were right in asserting the identity of the two products. They have also studied the action of bromine on β-naphthol sulphonic acid.

"*On Acetyl-ortho-amido-benzonic Acid*," by P. D. BEDSON and A. J. KING. Acet-ortho-toluidine was first prepared by heating ortho-toluidine with glacial acetic acid for several hours, and re-crystallising from aqueous alcohol; it was thus obtained in white needle-shaped crystals, melting at 107° to 109°. This compound was oxidised by the addition in small quantities at a time of potassium permanganate, the whole being warmed in a water-bath. The MnO_2, &c., was filtered off, and the acid precipitated directly by concentrated hydrochloric acid, or as a lead salt with lead acetate. The authors have studied the acid and some of its salts. The physical and chemical properties are given in the original paper.

A paper by Messrs. CROSS and BEVAN "*On the Formation of Sodium Hydrate from the Sulphate*," was taken as read.

The Society then adjourned to November 18, when the following papers will be read:—"Notes on the Oxides of Manganese," by Spencer Pickering; "Aluminium Alcohols (Part I., Their Preparation by Means of the Aluminium Iodine Reaction)," by J. H. Gladstone and A. Tribe.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, October 19, 1880.

E. W. BINNEY, F.R.S., F.G.S., President of the Section, in the Chair.

THE following communication from Dr. R. ANGUS SMITH, F.R.S., was read:—

In relation to my paper on the word Chemia, Mr. Wm. Simpson informs me that Dr. Muir, in "Sanscrit Texts," vol. v., p. 402, refers to the Rig Veda, where Kam is represented as Eros. Dr. Muir also says that Kama is distinctly identified with Agni, the Sanscrit for fire. This gives the word a firmer basis in the East than I found for it. He also adds that Wilford, in "Asiatic Researches," identifies Cæma or Kama of India with the Chemia or Chemi of Egypt. I shall add this to my paper, which is being printed in full. It is one of the proofs of early connection of Aryan and Semitic people both in language and thought; but this is a subject that belongs to others to speak of. I hear of other connections with the far East in the word Chemia, but having begun to argue this view of the case, others may advance it. When I say begun, I merely sought to connect old links of thought, and other old links may be found lying about in many places.

"*Additional Note on a Theory of Mixed Opaque Colours*," by JAMES BOTTOMLEY, D.Sc.

Professor REYNOLDS, F.R.S., said that he had been able to get a barometer tube free from air by first washing the tube with water, and introducing the mercury while the tube was wet, and then leaving the tube in an inverted position for several days. The water absorbed the air, and floating up between the mercury and the glass left the tube dry, full of mercury, and free from air. He hoped at the next meeting to report some further experiments on the suspension of mercury by its cohesion in a tube 90 inches long.

"*Some Endeavours to Ascertain the Nature of the Insoluble Form of Soda Existing in the Residue left on Causticising Sodium Carbonate with Lime*," by WATSON SMITH, F.C.S., Assistant Lecturer on Chemistry in the Owens College, and Mr. W. T. LIDDLE.

In the following are given the results of an enquiry (yet in progress) which were obtained towards the close of last session, in the Laboratory of Owen's College, by Mr. W. T. Liddle in conjunction with myself, and with the occasional co-operation of Mr. H. Rimmer. The present inquiry was the final step after a series of exercises in the technical examination of some alkali products by the two gentlemen named, kindly furnished by Messrs. Gaskell, Deacon, and Co.

Hargreaves (CHEM. NEWS, 387) and Kynaston (*Chem. Soc. J.*, 11, 135) have noticed the occurrence of soda in an insoluble form in the crude soda (black-ash) of the alkali works, but they only speak of alumino-silicates and silicates of sodium, and in these early papers mentioned do not appear to imagine any other insoluble compound present in which soda may be practically lost to the manufacturer.

Dr. C. R. A. Wright published a paper (appearing in *Journ. Chem. Soc.*, 1867, p. 407) in which he distinctly shows (1) that soda in an insoluble form does exist in black-ash treated with water, in process of lixiviation, and (2) that though it may partly exist as alumino-silicate, yet undoubtedly it exists in some other form, and most probably as a double sodium calcium carbonate.

To show the importance to the soda manufacturer of this loss in insoluble sodium compounds left behind in the black-ash and waste, Wright states that it forms the largest item of the several individual losses, making up the total 20·24 per cent loss out of 100 parts Na_2O as salt-cake occurring in the practical conversion of salt-cake to soda-ash. Wright tabulates this as follows:—

Previous to lixiviation of the black-ash:—	
Undecomposed sodium sulphate	3·49
Insoluble sodium compounds.....	5·44
Vaporisation, &c., of sodium compounds..	1·14
During and after lixiviation:—	
Soluble alkali left in vat waste	3·61
Leakage and losses in soda-ash process ..	6·56
Total loss per cent	20·24

In experiments tried with samples of black-ash Wright showed that on prolonged boiling (6 hours) with water, the insoluble sodium compound in the black-ash residue was decomposed, and yielded a sodium salt in solution capable of neutralising acid. On taking soda waste and submitting this to prolonged boiling with water, only 3·81 out of 5·08 per cent of the insoluble soda, calculated as Na_2CO_3, were extractible, and he considers that this difference from his experience with the black-ash is due to the influence of the other sodium salts present on the insoluble compound in the case of the black-ash. Wright also cites the well known fact, that on causticising sodium carbonate solutions with quicklime, the calcium carbonate formed retains a considerable portion of sodium in an insoluble form, and adds, that most probably in the case of the black-ash a double sodium calcium carbonate is formed, either in the furnace or on addition of water to the crude soda. In further proof of this view he mentions the case of some experimental charges for black-ash, in which an unusual excess of limestone was used. Wright examined the resulting product to see if more of this insoluble compound were formed, and found there was.

Mactear (CHEM. NEWS, Feb. 2, 1872, p. 55) makes the interesting discovery that "oxidised alkali waste yields on lixiviation almost all the soda contained in the waste." The soda thus rendered soluble occurs in the solution as sulphate. Mactear says "The chief loss in the soda process is that which occurs during lixiviation of the ball soda. This loss is in part represented by the insoluble and soluble compounds left in the waste. The former sometimes amounts to 3 or 4 per cent of the soda, and the amount is increased as the silica and alumina of the raw materials increase."

Wright has shown that an increase of limetone in the black-ash mixture will also increase the amount of the insoluble soda compound.

Scheurer-Kestner (*Comptes Rendus*, Nov. 11, 1872) confirms Wright's views. He proves conclusively that an

increase of chalk in the black-ash mixture causes a proportionate increase in the amount of insoluble soda compounds left in the waste. "The excess of chalk employed is converted into lime, and when the crude soda is lixiviated with water, the lime while becoming hydrated reacts upon the sodium carbonate, and thereby renders a portion insoluble in water." According to Scheurer-Kestner's experiments, the lime may retain even as much as from 4·75 to 4·95 per cent of soda Na_2O.

With regard to our own experiments, we first operated upon some samples of soda waste, with the view of determining the soluble and insoluble soda therein contained.

After titration and digestion with water of about 60° for an hour a sample of waste yielded us 0·22 per cent of alkali as Na_2O soluble in water. On solution of the residue in acid, a gravimetric determination of the residual and therefore insoluble soda gave 2·18 per cent Na_2O, hence the waste contained of total Na_2O—2·40 per cent.

Another sample analysed by Mr. Rimmer gave as

Soluble Na_2O—	0·31	per cent
Insoluble ,,	1·91	,,
Total	2·22	,,

Wright found in an average sample of a fortnight's soda-waste as

Soluble Na_2O—	2·07	per cent
Insoluble ,,	0·91	,,
Total	2·98	,,

In the difference noticeable between Wright's results and ours, as regards the insoluble soda, it is possible his own explanation for the fact that continuous boiling with water will extract the insoluble soda from black-ash, but will not from soda waste, may here hold good, for it will be noticed his soda waste contains considerably more soluble sodium salt than ours does.

We now turned our attention to the soda left behind in the lime sludge remaining as a residue in the process of causticising sodium carbonate solutions. In the sludge taken as a sample of many tons lying outside the causticising plant of a works after suitable draining, the total Na_2O extractible by water was found to be 2·62 per cent. Calculated roughly into dry residues this would represent 3·84 per cent.

Now according to several careful analyses made some years ago, the amount of soda existing in lime mud in the insoluble form averages about 2½ to 3 per cent. on the mud. If we add this to the above figure 2·63 per cent for the soda soluble in water, we get an approximate 5 per cent of total soda. In alkali works where black-ash is made, this soda is not lost, the mud, drained and dried as far as possible, being mixed with the black-ash charges, and worked into ball soda, and thus it is kept in constant circulation, instead of being lost. The loss entailed thereby is one of heat, and hence of fuel, in converting water into steam in the black-ash furnace.

In order to have some object to aim at, we commenced the next step by assuming the existence of such a double sodium calcium carbonate, as Wright believes is formed, under the circumstances already named; and, as the simplest mode of representing such a compound, we took the liberty of giving the formula

$$Ca\begin{cases}CO_3Na\\CO_3Na\end{cases}$$

We then made an attempt to prepare this so far hypothetical salt. But before proceeding to this, we will just refer to some experiments we made with the object of ascertaining with some degree of precision under what circumstances the insoluble sodium compound is formed.

Solutions or caustic soda and sodium carbonate were prepared; the form had a specific gravity of 1·09 and contained 6·52 per cent Na_2O; the latter contained 5·985 per cent Na_2O.

(I.) A quantity of precipitated $CaCO_3$ was diffused in water and boiled then with 20 c.c. of standard caustic soda for 15 minutes. After filtering and washing till the filtrate was no longer alkaline, it was found by titration with normal hydrochloric acid that no soda had been retained by the calcium carbonate.

(II.) No soda was retained either, when instead of the precipitated $CaCO_3$ finely powdered marble was used.

(III.) A quantity of calcium carbonate (precipitated) was now boiled for a long time with 20 c.c. of the sodium carbonate solution of known strength and with the addition of water. No soda was retained.

(IV.) The above experiment was repeated with finely powdered marble, with like negative results.

(V.) A quantity of milk of lime was now taken, and boiled with 25 c.c. of the Na_2CO_3 solution. After filtering, washed with 500 c.c. of hot water, removed lime, filtered, washed, evaporated to dryness, ignited, dissolved in water, and titrated, 1·286 per cent Na_2O was retained by the calcium residue.

(VI.) A quantity of milk of lime taken, and to it were added 25 c.c. of caustic soda solution with some water. The whole was boiled for some time—0·05 per cent Na_2O retained. Some of the sodium hydrate becoming accidentally carbonated might account for this.

This lime mud residue of (V), washed as above till the filtrate ceased completely to react alkaline, was washed into a flask and a current of CO_2 was passed through for a long time, to endeavour to decompose this insoluble compound. In this way only 0·078 per cent of the soda (Na_2O) was extracted.

We now attempted to prepare some of the double sodium calcium carbonate in the following manner:—

A quantity of pure sodium carbonate solution (somewhat concentrated) was mixed with about three times its volume of clear lime water, and this mixture was heated to boiling. The precipitate was allowed to settle, was filtered, and washed with hot water till the filtrate ceased to manifest the slightest alkalinity to test paper. It was then dried in the water-bath. When the lime water was added to the sodium carbonate solution, the precipitate of carbonate which came down had the floccular appearance of alumina freshly precipitated, but on standing for about half an hour without heating, it became crystalline in appearance. The dried precipitate under the microscope was distinctly crystalline, being apparently composed of minute rhombohedra.

In subsequent experiments we found the microscopic appearance to vary, sometimes rhombohedra mixed with minute prisms making their appearance.

On analysis we found that the crystalline powders (they were only just perceptibly crystalline to the naked eye) contained according to two experiments:—

$CaCO_3$		Na_2CO_3
(1)	(2)	
67·65%	97·90%	2·46%

It would seem probable from this that the major reaction, so to say, is that converting sodium carbonate into hydrate, calcium hydrate passing into *pro ratâ* carbonate, but a minor reaction also occurs by which a small quantity of a double carbonate is formed. It is all the more certain that such a compound actually is formed from the fact that the precipitates obtained as just mentioned (and this experiment has been repeated many times) were in every case distinctly crystalline powders; we never detected the smallest amorphous particle with the microscope. Now it is hard to imagine any difficulty in removing sodium carbonate by continued washing with boiling water in excess, from a powder consisting of distinct crystals of calcium carbonate. We can then best account for the presence of the alkali by considering it as having formed itself, a crystalline and insoluble compound with calcium carbonate, this double crystalline carbonate being mixed in small quantity with the superabundant calcium carbonate.

Another experiment was now tried, to prove indirectly

if such a double carbonate were present in the crystalline precipitated powders we obtained as already described. We reasoned thus: "If such a double compound exist here, strong ignition ought to decompose it, driving off carbon dioxide from the lime, but leaving sodium carbonate in tact," thus

$$Ca\begin{matrix}CO_2ONa\\CO_2ONa\end{matrix} = CaO + Na_2CO_3 + CO_2$$

This experiment was tried with a small quantity of the crystalline precipitate. It was well ignited in a platinum crucible, and the resulting mass was treated with some dilute alcohol, which extracted easily a quantity of the soda, showing a strongly alkaline reaction to test-paper. We intend to repeat this experiment quantitatively, and to determine thus the amount of soda extracted.

One point becomes pretty clear by these experiments, viz., that the materials lime and sodium carbonate in contact with water give rise to the formation of this insoluble sodium compound. Also that it is not a case of mere cohesive retention of soda by the lime mud, for our experiments show that until a definite and suitable chemical reaction between the members of the mixture sets in, no appreciable amount of soda is retained, but that when such reaction sets in, in the condition of nascent state and therefore unstable equilibrium, in which the various constituents momentarily find themselves, a major and normal reaction takes place, and also this minor reaction to a small extent—giving us a small yield of the insoluble sodium compound.

The experiments we have yet in view with the crystalline precipitate prepared as mentioned, and also with ordinary lime mud, are (1) the effect of long boiling with water to see if thus the insoluble compound is decomposed, as with Wright in the case of the black-ash; (2) boiling with water containing certain salts in solution, such, *e.g.*, as sodium sulphide. We hope by obtaining a closer knowledge, at all events, of the properties and behaviour of this singular compound, to find at length, peradventure, a practical and ready means for extracting it, and thus doing a service to the alkali manufacturer.

THE AMERICAN CHEMICAL SOCIETY.*

The September Conversazione was held on Thursday, September 23, 1880.

Dr. Leeds exhibited a number of new compounds obtained during the course of a research upon the action of hyponitric anhydride upon organic bodies. The most important of the substances obtained thus far had been those derived from benzene and naphthalene. The former dissolves large volumes of hyponitric anhydride, more especially in the cold, and increases greatly in bulk. After long-continued standing the liquid loses its dark red colour, and is found to contain a large amount of bitter almond oil. An abundant crop of crystals of oxalic acid slowly settles out, and this method, though very tedious, is the best one, since, on attempting to distil off the liquid portions, a quantity of dark red oil is formed, which greatly interferes with the subsequent operations. By boiling with water, the unaltered benzene and mono-nitro-benzene are driven off, and on concentrating the solutions thus obtained, a mass of yellow fern-like crystals separates out, which, on recrystallisation from chloroform, proves to be picric acid. In the distillate from the benzene after nitration, two bodies had been obtained which had been separated by means of their different behaviour towards solvents; the one soluble in alcohol, from which it crystallises in slender prismatic needles of a faint reddish yellow colour; the other insoluble in alcohol but soluble in benzene, from which it crystallises in brilliant lemon-yellow prisms. Only the former had as yet been obtained in quantity sufficient for analysis, its formula being C_6H_4O, monoxybenzene. When naphthalene is similarly treated it rapidly liquefies, with the formation of an abundant deposit of needle-shaped crystals of mono-nitro-naphthalene. On exhausting the nitrated mass with water, evaporating the filtered solutions to dryness, and subliming, long flat pearly needles are given off, which on re-sublimation had a melting-point of 131°. Their analyses having given irrational formulæ, they were re-crystallised from hot benzene. On cooling, minute fern-like crystals separated out, and afterwards, on long standing, another crop, which on re-crystallisation formed large monoclinic prisms, perfectly colourless, and of a high vitreous lustre. Both of these bodies proved to be new substances, the former having the composition, $C_{10}H_8O_4$, tetroxy-naphthalene; the latter, $C_{10}H_4O_4$, naphtho-diquinone. Besides the mono-nitro-naphthalene, α-dinitro-naphthalene was obtained by appropriate treatment of the nitrified substance, before its exhaustion with water.

A specimen of paratoluic acid was likewise exhibited, obtained by submitting cymene to the action of hyponitric acid. It was obtained by exhausting the nitrated cymene with boiling water, a small amount of α-nitro-cymene passing off in the distillate at the same time. As yet the action upon anthracene had not been completely studied, but a number of specimens of the anthraquinone, the principal product obtained when anthracene is treated with hyponitric anhydride, were exhibited to the Society.

* Communicated by Arthur H. Elliott, F.C.S., Recording Secretary.

CORRESPONDENCE.

WELDON MUD.

To the Editor of the Chemical News.

Sir,—An expression in Dr. Post's letter in the Chemical News, vol. xlii., p. 233, may lead some of your readers to suppose that, in the replies which I have had occasion to make to certain papers of his, I have overstepped the limits of fair controversy. Those replies consist simply of a letter published by yourself some months ago, and a paper read before the Newcastle Chemical Society on the 25th March last. The former your readers have seen; but as very few of them can have seen the latter, you will perhaps permit me to say that it deals simply with the published results of Dr. Post's analyses of Weldon mud, showing that they are not in accordance with the results of manufacturing experience, and that if Dr. Post does not find in the product made in the Weldon oxidiser all that part of the CaO unquestionably put into the oxidiser which has not been employed to decompose $MnCl_2$ or other chlorides, either his analysis must be inaccurate, or CaO must have been annihilated. To point out to him that dilemma is surely not to make "attacks" on Dr. Post.—I am, &c.,

Walter Weldon.

Rede Hall, Burstow, November 6, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
No. 11, June 5, 1880.

Perforation of Zinc Cisterns and Corrosion of Lead Pipes by Water.—X. Rocques.—The author observes that the plates of zinc cisterns are corroded, not uniformly, but in certain well-defined places. The cause of this inequality is the electric current, which is set up

between the purer portions of the metal and those more alloyed. Zinc, lead, and copper are attacked very slowly by ordinary water and by saline solutions in general (chlorides, bicarbonates). The corrosion is more rapid if there are several metals in contact. The presence of nitrogenous matters and ammonia accelerates the action, especially in case of zinc. The phenomena display their greatest activity in presence of oxygen. This is the case at the surface where the metal is alternately in contact with water and air. The deposits formed are chiefly silicates and carbonates of lead, zinc, and copper.

Density of the Vapour of Iodine.—J. M. Crafts and F. Meier.—Already noticed.

Formation-Heat of Ammonia.—M. Berthelot.—Already noticed.

Formation-Heat of the Oxides of Nitrogen.—M. Berthelot.—Already noticed.

Observations on a Paper by MM. Vincent and Delachanal on Pure Methyl Cyanide.—A. Gautier.—The physical constants characterising methyl cyanide given by MM. Vincent and Delachanal are almost identical with those published by the author in 1868 and 1869. (*Annales de Chimie*, Series 4, xvii., p. 103.)

Tetric and Oxy-tetric Acids and their Homologues.—E. Demarçay.—This memoir does not admit of useful abstraction.

Detection and Determination of Heavy Mineral Oils, Resin, and Fatty Oils in the Oils of Commerce.—A. Rémont.

Gazzetta Chimica Italiana.
Anno 10, Fasc. 2, 1880.

Physico-Chemical Analysis of Arable Soils.—Prof. Fausto Sestini.—The author concludes from the experiments instituted at an "Agricultural Station," that the method of Schlœsing (communicated to the Academy of Sciences in 1874) is the only one which renders it possible to determine sufficiently well the proportion of clay in cultivated soils. The liquid may without prejudice to the exactness of the operation be allowed to settle for twelve hours, instead of twenty-four as proposed by Schlœsing. The number of washings should be increased from six to twelve, using a small pencil to detach entirely the clay from the sand. Neither the clay nor the sand as thus separated are of constant chemical composition, and it would be preferable to call them clayey matter and sandy matter.

Succinine.—Dr. Angelo Funaro and Leobaldo Danesi.—The authors give $C_7H_{10}O_5$ as the formula of pure succinine.

Colouring Bases Derived from Furfurol.—Ugo Schiff.—The author has examined the behaviour of diphenylamine, meta-nitraniline, para-nitraniline, toluendiamine, and benzidine with furfurol, and has obtained a number of coloured compounds. Diphenylamine unites with furfurol in the proportion of two mols. of the base to one of furfurol. The diphenylamine employed was previously freed from aniline and toluidine. At the heat of 150° there was obtained a brown oily liquid, which at 0° congealed into a crystalline mass. The addition of hydrochloric acid gives a compound of a magnificent bronze colour, which dissolves in alcohol with a very intense crimson.

Certain Compounds of the Myristic Series.—Dr. F. Masino.—The author has examined myristine, myristic acid, myristamide, and myristolic acid.

The Crystalline Form of Nitroso-thymol, Lapacic and Cuminic Acids.—Dr. Ruggiero Panebianco.—Of no value without the accompanying diagrams.

Formation of the Fatty Matter and Ripening of the Olive.—Dr. Angelo Funaro.—The author gives tables showing the respective weights of the pulp and kernel of the olive at different stages of growth, of the average bulk of the pulp and kernel, and of the proportions of moist-dry matter, and matter soluble in ether both of the pulp and in the leaves.

Analysis of Four Samples of Water from Turin.—Ad. Lieben.

Analysis of Four Waters from Turin.—Stanislao Cannizaro.—These papers, the former of which is very voluminous, enter upon the general question of the analysis of water from a sanitary point of view, and discuss the value of various methods.

Revue des Industries et des Sciences Chimiques et Agricoles.
No. 27, 1880.

Analysis of the Incrustations formed in Triple-Action Apparatus, and its Removal.—The apparatus in question is used in the manufacture of beet-root sugar. The deposit varies not merely in different works, but in different parts of the apparatus, and may contain 60 per cent of silica. It is removed by boiling soda-lye and milk of lime in the apparatus.

Pyrogenous Chemical Products Derived from Wood.—A. Bresson.—This paper is the continuation of a controversy, rather commercial than scientific in its objects.

On Lead and its Salts with Regard to Public Health.—Dr. Rœser.—An account of the trades—much more numerous than is commonly thought—in which workmen are exposed to the action of lead, and of the maladies to which they are consequently liable. It appears that the mechanical uses of lead are scarcely less dangerous than its chemical applications.

Chemisches Central-blatt.
No. 25, 1880.

On Glykosamine.—G. Ledderhose.—Glykosamine is a decomposition product of chitine, for which latter the author proposes the formula $C_{15}H_{26}N_2O_{10}$. Two mols. chitine take up 6 mols. of water and form 3 mols. acetic acid and 4 of glykosamine.

MEETINGS FOR THE WEEK.

SATURDAY, 13th.—Physical, 3. "On the beats of Mistuned Consonances of the Form $h:1$," by R. H. M. Bosanquet. "Note on Prof. Exner's paper on Contact Electricity," by Profs. Ayrton and Perry. "On Action at a Distance," by Walter R. Browne. "Thermo-dynamic Relations of the Thermal and Ergonal Constituents of Heat in Liquids and Gases."

MONDAY, 15th.—Royal Academy of Arts, 8. "The Chemical and Physical Changes Involved in the Several Processes of Painting," by Arthur H. Church, M.A.

—— Medical, 8.30.

TUESDAY, 16th.—Civil Engineers, 8.

WEDNESDAY, 17.—Society of Arts, 8,

—— Geological, 8.

—— Meterological, 7.

THURSDAY, 18th.—Royal Academy of Arts, 8. "The Conservation and Restoration of Pictures," by Arthur H. Church, M.A.

—— Royal, 4.30.

—— Royal Society Club, 6.30.

—— Chemical, 8. "Notes on the Oxides of Manganese," by Spencer Pickering. "Aluminium Alcohols (Part I., Their Preparation by means of the Aluminium Iodine Reaction)," by J. H. Gladstone and A. Tribe. "On the Synthetical Production of New Acids of the Pyruvic Series (Part II.)," by Edward Moritz.

TO CORRESPONDENTS.

A. T. F.—The "Note on Hydroxyl" is not suitable for insertion, being a suggestion only, quite at variance with known chemical laws.

Answer to W. R. E. Grantham.—(1) Dr. Lunge's "Manufacture of Sulphuric Acid and Alkali," J. Van Voorst, Paternoster Row. (2) "Destructive Distillation," by Dr. E. J. Mills; Van Voorst. This subject requires a whole library if our correspondent wishes to enter into all its branches.

MIDLAND RAILWAY.

CHEMICAL ANALYST WANTED.

The Directors of the above Company are prepared to receive applications from competent persons desirous of filling the above appointment. Salary to commence at £200 per annum. Applications with testimonials to be sent in addressed to the Secretary of the Locomotive Committee, Midland Railway, Derby, and must be received not later than 9.0 a.m. on Saturday, 27th November, 1880.

JAMES WILLIAMS, Secretary.

Derby, 3rd November, 1880.

MR. J. S. MERRY,

ASSAYER AND ANALYTICAL CHEMIST,

SWANSEA.

SOUTH LONDON CENTRAL PUBLIC LABORATORY.

A Department has been opened for the Private Instruction of Gentlemen in Practical Chemistry as applied to any Special Industries or Commercial Products they may wish to study. For Fees, &c., apply to W. BAXTER, Secretary, Central Public Laboratory, Kennington Cross, S.E.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

ROYAL POLYTECHNIC.—Asmodeus, the Bottle Imp. Ventriloquism and Magic, by Professor Hellis. Modern and Machine Guns, the New Forest, the Oxy-hydrogen Microscope, &c., by Mr. J. L. King. Musical Entertainment by the talented Adison family. Sights of London, by Mr. Heath. Blondin and Leotard, the marvellous Automata. Diving Bell, Moving Machinery and Models. The Royal Polytechnic Barometer, &c. Stokes on Memory, Tuesdays and Thursdays at 7. Open 12 till 5, and 7 till 10. Admission 1s.

MOTTERSHEAD & CO.,

7, Exchange Street and 10, Half Moon Street,

MANCHESTER.

CHEMICAL & PHYSICAL APPARATUS,

BOTTLES, PURE CHEMICALS,

REAGENTS, STANDARD SOLUTIONS,

And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

BETHESDA MINERAL SPRING,

WAUKESHA, WISCONSIN, U.S.A.

Invaluable in Diabetes, Bright's Disease, Urinary Diseases, Dyspepsia. A Mild Aperient. Sold by all Chemists and Mineral Water Agents. Agents wanted.

For special terms and further information apply to CEARNS and BROWN, 32, Chapel Street, Liverpool.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

Wanted, to Purchase Volumes 1, 3, 5, 6, and 7, of the "Journal of the Chemical Society"; also Vol. 3 of the "Proceedings of the Royal Society."—Address, K. P. G., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

GREENBANK ALKALI WORKS COMPANY (LIMITED),

ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{8}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{3}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

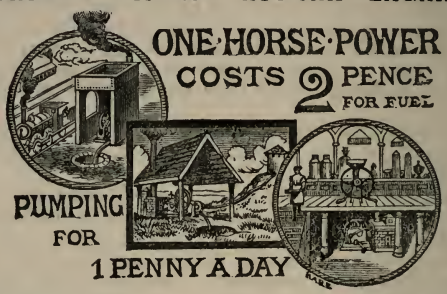
BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application. Orders for small quantities executed for Cash against Invoice.

BAILEY'S PATENT HOT-AIR ENGINE.



Made from ¼ to 5 horse-power. 56lbs. of coke will keep a 1-horse going 12 hours. 1000 galls. of water lifted 50 feet high for a penny.

NO BOILER. NO DANGER.

Awarded Prize Medal by the chief Societies.

SOLE MAKERS—

W. H. BAILEY & Co., Albion Works, Salford, Manchester.

BISULPHITE OF LIME.

BISULPHITE OF SODA.

SULPHITE OF SODA. TANNATE OF SODA

WILLIAM MARRIOTT

CHEMICAL WORKS, HUDDERSFIELD

SILICATE OF SODA, Solid and in Solutions of Various Degrees of Concentration: the finest quality obtainable, and especially adapted for the use of Soap Makers and other Consumers.—JOSEPH CROSFIELD and SONS, Soap Makers, &c., Warrington.

London Agent—H. B. CLARKE, Great Tower Street, E.C.

THE CHEMICAL NEWS.

Vol. XLII. No. 1095.

ON THE

MEASUREMENT OF CHEMICAL AFFINITY.*

By C. R. ALDER WRIGHT, D.Sc. (Lond.),
Lecturer on Chemistry in St. Mary's Hospital Medical School.

Some half century or so ago, affinity was defined in the text-books as a species of attraction exerted between the particles of bodies of dissimilar or different kinds when brought together, whereby there are produced not mere aggregations of particles of similar characters due to cohesion (such as would result were the particles of the same kind), but new groups of particles constituting bodies different in character from the original substances. Thus, on breathing into lime-water, the carbonic acid of the breath was said to unite with the lime, forming carbonate of lime, in virtue of the peculiar affinity which the particles of lime and of carbonic acid have for one another respectively. It was then known by experiment that occasionally one substance could displace another from chemical combination; *e.g.*, copper is thrown down by iron from blue vitriol solution, silver by mercury from lunar caustic, and lead by zinc from sugar of lead, forming "trees." This class of action was explained by saying that the affinity of sulphuric acid for iron was greater than that for copper; and similarly in the other cases, the phrase "elective affinity" being employed to indicate the apparent preference of the sulphuric acid for the copper, of the nitric acid for the mercury, of the acetic acid for the zinc, and so on. Similarly it was known that two salts would often mutually decompose one another, *e.g.*, that carbonate of potash added to nitrate of lime would form carbonate of lime and nitrate of potash, and this was explained by supposing that the affinity of carbonic acid for lime plus that of nitric acid for potash, jointly exceeded the sum of the affinities of carbonic acid for potash and nitric acid for lime; so that the former (referred to as *Divellent affinities*) being in excess of the latter (*Quiescent affinities*), decomposition of the first two compounds and simultaneous recombination of the resulting acids and alkalies in a more stable form necessarily resulted.

It was evident to the thinkers of that epoch (to quote from one of them, Dr. Henry) that "the determination of the precise forces of affinity would be an important step in chemical philosophy, for its phenomena would then be reduced to calculation, and we should be able to anticipate the results of experiment." Although very much yet remains to be done in this field before anything like a sufficiently wide and extended basis for such predictions is obtained for chemical phenomena generally, yet during the last few decades a good deal has been accomplished tending in this direction.

The establishment of the principle of the conservation of energy, with the experimental portion of which work the name of Joule is indissolubly connected, affords the primary means of making such determinations. In the course of the various researches hitherto made on the development of energy (to outward appearance) by chemical actions, the proposition has been abundantly verified that in all such instances there is no real creation of force or increase in the total energy of the universe, but that each body met with in nature has, so to speak, stored up in it a supply of latent or potential energy (somewhat after the fashion in which heat is rendered latent in melting ice or boiling water), and that the actual energy obtained by means of a chemical change (*e.g.*, when coal is burnt under the boiler of a steam engine) is derived from the lessening of the store of potential energy contained in the chemicals employed (the fuel and the atmosphere); so that the development of energy may be put in the form of the equation—

$$A+B+\ldots.=C+D+\ldots.+W$$

or otherwise— $\Sigma(A)=\Sigma(B)+W$

where A and B . . . are respectively the amounts of potential energy latent in the materials employed, jointly $=\Sigma(A)$; and C, D, ... are respectively the amounts of potential energy latent in the resulting products, jointly $=\Sigma(B)$, W being the amount of energy which is converted from the potential into the actual state during the chemical change. Just as the principle of the indestructibility of matter inculcates that the sum of the masses of the reacting bodies is equal to the sum of the masses of the products, no matter what the variation in the ways in which they are associated, so the principle of the conservation of energy tells us that the sum of the actual and potential energy of the materials is equal to that of the products, so that whatever actual energy is apparently gained is really obtained at the expense of the potential energy of the system.

Of course, if this proposition is universal it must equally embrace the case where W has a − sign, that is, when the performance of a chemical change causes an apparent disappearance of energy (*e.g.*, an absorption of heat); in short, if $\Sigma(A)=\Sigma(B)+W$, $\Sigma(B)=\Sigma(A)-W$, so that the inversion of a given chemical change requires the increase of the amount of potential energy of the system by an amount precisely equal to that by which it is decreased by the original change, the increase and decrease of potential energy being each precisely equal to the decrease and to the increase of the actual energy in the inverted and original changes respectively; *e.g.*, in the burning of a given weight of hydrogen and oxygen, together forming liquid water, a conversion of potential into actual energy takes place to a definite extent, usually producing the visible effect of heat evolution. In order to "unburn" the water (to use Dr. Odling's phrase), *i.e.*, to decompose it into the original hydrogen and oxygen, just as much actual energy must become potential, causing a precisely equal heat absorption. The determination of the "precise forces of affinity," referred to by Dr. Henry as so desirable, or, at least, the determination of their resultant in any particular case, is then made by determining the amount of energy which passes from the actual to the potential state, or *vice versa*, during the performance of a chemical change occurring with known masses of reagents.

Hence it results that there are two principal ways in which the extent of conversion of actual into potential energy, or *vice versa*, in any given chemical change may be measured, viz., the determination of the numerical value of W in the chemical change referred to by the equation representing the energy-changes—

$$\Sigma(A)=\Sigma(B)+W,$$

in which potential energy becomes actual; and the determination of the same numerical value in the converse chemical change referred to by the equation—

$$\Sigma(B)=\Sigma(A)-W,$$

in which actual energy becomes potential.

Hitherto most of the measurements that have been made have been performed by the first method, for it is found experimentally that reactions in which actual energy becomes potential as the nett result, on the whole occur very rarely, if at all, at ordinary temperatures at any rate; and when they do apparently occur, in many cases the apparent absorption of heat is demonstrably due to change of physical state of some one of the substances involved in the change; so that the measurements have practically been made by bringing together known masses of materials, causing them to undergo chemical change, and finally measuring

* Opening Address to the Owens College Chemical Society. October 29, 1880.

by means of the calorimeter the quantity of heat liberated as the nett result of the actions taking place.

Upwards of thirty years ago, however, Joule, and also Woods, experimentally indicated the possibility of applying the second method to the same general purpose, the energy rendered latent or potential being derived not from a spontaneous chemical change, but being subtracted from that which a given electrical current would otherwise yield; *i.e.*, they measured the amount of heat-absorption taking place when certain compounds are decomposed by the electric current (electrolysed) by determining the difference between the heat actually generated, and that which the current would have generated had all the work done by it been performed as heat and none as chemical decomposition. Very shortly afterwards Sir William Thomson worked out the mechanical theory of electrolysis on these principles, and advanced the theoretical aspect of the question to a point beyond which but little progress has since been made. It results from his demonstrations that it is just as convenient to measure energy in terms of electromotive force as in terms of heat, the two measurements being convertible. By pursuing his line of argument and working it out practically, I find that the experimental measurement in terms of electromotive force may be made to yield information about the internal mechanism of a given chemical change, which the calorimetric determination by the first method is unable to give, whilst it equally gives the value of the energy corresponding to the nett result of the total changes ensuing (*vide infra*).

By comparing together the results of determinations of the heat evolved in chemical changes made by Andrews, Favre and Silbermann, Berthelot, Julius Thomsen, and many others, but more especially the two last-named, a large body of information is gradually being accumulated, the importance of which is daily increasing; indeed, it seems highly probable that "thermo-chemistry" will eventually become more important from a theoretical point of view than any other branch of chemistry, and that the fundamental facts of the science will be shown by-and-bye to be natural consequences of the thermal qualities of bodies. As examples it may be noticed that wherever an "elective affinity" is exerted, as when copper is displaced by iron, lead by zinc, &c., the end result of the transaction is an evolution of heat, *i.e.*, such changes only occur when the *heat of combination of the displacing body is greater than that of the body displaced.*

In many cases the energy of combination of analogous elements with another element (measured per equivalent weight of each) is found to decrease in the equivalent increases; for instance in the synthesis of the following compounds:—

Formula.	Weight of Substance in Grms.	Heat Evolution.
HCl	36·5	+22,000
HBr	81	+ 8400
HI	128	− 6000
H_2O	18	+68,000
H_2S	34	+ 4500
H_2Se	80	− 5400

But this is by no means an invariable rule. Thus certain tellurion compounds produce a greater heat evolution than the corresponding selenion compounds, whilst aqueous iodic acid develops more heat than aqueous bromic acid during synthesis. The combination of cyanogen with potassium evolves less heat than that evolved by the combination of either chlorine, bromine, or iodine with potassium, although these latter follow the same order as the heats of combination of hydrogen with chlorine, bromine, and iodine respectively.

According to Thomsen the quantities of heat given out in many reactions are related to one another after the same fashion as the quantities of chemical substances that combine with one another, *i.e.*, their ratio is a simple multiple of a constant ratio; thus, in many cases he finds that the heat evolution is a multiple of a number lying close to 18,000. Using Thomsen's notation [where the comma means combination, so that (H_2,S,O_4,aq), for instance, means combination of 2 grms. of hydrogen, 32 of sulphur, 64 of oxygen, and an unlimited amount of water of solution], the following specimen numbers may be quoted (*Berichte Deut. Chem. Ges.*, 1873, 239):—

$$(N_2O_2,O,aq) = 2\times18{,}170$$
$$(N_2O_2,O_2,aq) = 3\times18{,}214$$
$$(N_2O_2,O_3,aq) = 4\times18{,}235$$

$$Hg_2Cl_2,aq,Cl_2 = 2\times18{,}537$$
$$2FeCl_2,aq,Cl_2 = 3\times18{,}270$$
$$SnCl_2,aq,Cl_2 = 4\times18{,}469$$
$$SO_2,aq,Cl_2 = 4\times18{,}477$$

$$Mn_2O_7aq,5H_2O_2aq,2SO_3aq = 10\times18{,}924$$
$$Mn_2O_7aq,5H_2O_2aq,4HClaq = 10\times18{,}218$$

$$(Cu,O,SO_3,aq) = 3\times18{,}705$$
$$(Cd,O,SO_3,aq) = 3\times18{,}094$$
$$(Pb,O,SO_3,aq) = 4\times18{,}888$$
$$(Fe,O,SO_3,aq) = 5\times18{,}772$$
$$(Zn,O,SO_3,aq) = 6\times18{,}077$$
$$(Mg,O,SO_3,aq) = 10\times18{,}092$$

$$Br_2aq,H_2 = 3\times18{,}551$$
$$Cl_2aq,H_2 = 4\times18{,}441$$
$$H_2O_2aq,H_2 = 5\times18{,}335$$

And similarly in other cases, a numerical value near to 18,000 being uniformly an exact divisor of the heat-evolution during the synthesis of a substance, even when belonging to very different classes of compounds in different cases respectively.

What I more particularly propose to bring before you to-night is the general result of a large amount of my own personal work in this field of research carried on during the last few years, and in many respects at present only in a partially developed and incomplete state; and I am the more tempted to do so because whilst the field is very wide, the labourers in it are but few, and I am persuaded that a rich harvest of results will reward patient investigation in the domain, and that if by putting before you some ideas concerning certain of the directions in which experiments have been or may be made, I can induce any of you to take up this line of research, both the investigator himself and science generally will be benefitted.

One class of experiments then, on which I have bestowed a large amount of time and attention is the investigation, in conjunction with Messrs. Luff and Rennie, of the circumstances attending certain chemical changes of the "elective affinity" class (*i.e.*, represented by the reaction, AB+C=A+BC, where C displaces A from combination with B), which do not take place at the ordinary temperature, but do at temperatures a little elevated, but still readily measurable. The final result of these observations is that a distinct correlation exists between the temperature, the rate at which the action proceeds under constant conditions, and the nett amount of heat generated (or absorbed) by the reaction as a whole. The substances chiefly investigated hitherto have been the metallic oxides and certain reducing agents which will remove oxygen from them (*e.g.*, Fe_2O_3 or CuO, and H_2 or CO), and the general law obtaining in such cases may be put thus:—The greater (algebraically) is the heat-evolution (*i.e.*, the greater the actual evolution or the less the absorption), the lower is the temperature requisite to bring about a given amount of reduction in a given time (under constant conditions), the shorter the time requisite to effect a given amount of reduction at a given temperature, and the greater the amount of reduction brought about at a given temperature in a given time: from which it results as a particular case that a given reducing agent will act to a just measurable extent in a given time (*i.e.*, will just

visibly begin to produce reduction) at a lower temperature with a metallic oxide, the reduction of which is accompanied by a greater (algebraic) heat-evolution, than it will on another which evolves less heat during reduction; or that a given metallic oxide will be reduced to a just perceptible extent at a lower temperature by a reducing agent evolving more heat during its union with O, than by one evolving less heat.

The above general law may be expressed graphically thus:—Let the time, the temperature, and the amount of reduction be measured off respectively along three rectangular coordinates, and let the points thus obtained be connected so as to form a curved surface; then the surface corresponding to the lesser heat-evolution under constant conditions always lies inside the other surface.

In actual experiment this is not absolutely always the case; but in the few instances where the normally underlying surface projects above the other one, the cause is always found to be an inequality of the conditions. For instance, when hydrogen and CO act on Fe_2O_3 the actions are not absolutely identical; in each case there is an action of the form—

$$Fe_2O_3+3X=3Fe+3OX,$$

but with the CO there is also a tendency to a secondary reaction—

$$Fe_x\,O_y + CO = C + Fe_x\,O_{y+1}$$

where the CO acts as an oxidising agent, which of course diminishes the total nett reducing action of the CO. This interfering action has no parallel with hydrogen; its effect (with one particular kind of Fe_2O_3 examined) was to make a small extent of the surface corresponding to the CO lie inside that corresponding to the H, instead of outside as should be the case in accordance with the law, and as actually was the case with the great majority of the surfaces. Again, CO diffuses less rapidly than H_2 and H_2O vapour than CO_2, so that when reduction has gone on to a certain extent and the particles of substance are coated exteriorly with a film of reduced metal or lower oxide, the penetration through this film of the hydrogen and the removal of steam are both carried on more rapidly relatively than is the case with CO and CO_2; and hence the rate of reduction by CO is somewhat retarded relatively to that of the hydrogen, the effect of which is in certain cases that the hydrogen surface instead of underlying the carbon oxide surface, reaches above it.

A peculiar phenomenon is sometimes noticeable in the earlier stages of a given reaction, viz., a gradual acceleration of the rate of reduction by a process of "chemical induction" precisely analogous to the "photo-chemical induction" studied by Dr. Roscoe in conjunction with Prof. Bunsen. This is most distinctly marked at lower temperatures, and at certain particular temperatures causes the curious result that the amount of action during considerable periods of time (from several hours to days or even weeks), after first bringing together the substances in question, is so small as not to be measurable, but by-and-bye a notable action becomes manifest, the rate of change continually increasing: so that a "period of incubation," so to speak, exists during which the rate of action is too small to be measurable, and after this is over action becomes apparent and measurable. *Cæteris paribus*, the duration of this period of incubation is less the higher the temperature, becoming too brief for measurement at temperatures above a certain limit, and so prolonged as to be practically infinite (at any rate lasting over years) at temperatures below a certain lower limit.

I have recently obtained some interesting results (at present unpublished) by studying, in connection with Messrs. Rennie and Menke, the nature of the curved surfaces obtained during the reduction of the higher oxides of metals which form more than one oxide. When the different oxides of a given metal are formed with about the same amount of heat evolution (per constant quantity of oxygen added on)—*e.g.*, with copper as metal—the curve traced out for any given temperature as reduction proceeds exhibits no abrupt alteration in direction at any point. At first it is concave upwards whilst induction is proceeding, and subsequently it becomes concave downwards when the quantity of reduced substance accumulates to such an extent as to retard the action by covering up mechanically the as yet unreduced, or imperfectly reduced, portion, the point of contrary flexure varying with circumstances, and being lower down, *cæteris paribus*, with CO than with hydrogen, owing to the greater diffusive power of the latter enabling it to penetrate the superficial layer of reduced metal more readily.

But if the heat of formation of the higher oxide is less than that of the lower ones (measured per constant quantity of oxygen added on) the direction of the curve becomes notably altered in the direction of retardation of rate of action when the higher oxide has lost so much oxygen that the composition of the mass is sensibly that of the lower oxide. Thus in the case of manganese dioxide an "angle" in the curve line is noticeable when the mass is so far reduced as to be sensibly Mn_3O_4; and when the mass has the composition MnO reduction at temperatures below a bright red heat stops altogether. When ferric oxide is thus examined an "angle" always exists in the curve at a point representing the composition Fe_3O_4: but none is found at any other point, from which it results that the heat of formation of all oxides of iron up to Fe_3O_4 is sensibly the same per equal amount of oxygen consumed; but the heat of formation of Fe_2O_3 is less; just as the heat of formation of MnO is greater than that of Mn_3O_4, which appears to be greater than that of Mn_2O_3, MnO_2, or any other higher oxide. It is comprehensible, therefore, why intense heating of any higher oxide of manganese, *per se*, may reduce it to Mn_3O_4, but no further, the action stopping at that point, because Mn_3O_4 is more stable as regards tendency to split up by heat than higher oxides. Similarly iron, when oxidised at very high temperatures, burns to Fe_3O_4, and not Fe_2O_3, for the same reason. Presumably, if Fe_2O_3 were very highly heated, *per se*, it would evolve oxygen and become Fe_3O_4.

Another branch of the subject to which I have given attention is that of the nature of the deductions to be drawn from calorimetric determinations in the field of organic chemistry. It has been shown by Berthelot, Thomsen, and Hermann that by comparing together the heats developed during the combustion to CO_2 and H_2O of various organic products, and of the amounts of solid carbon and gaseous hydrogen contained therein, it becomes possible to deduce the amounts of heat that would be generated during the synthesis of the various organic bodies from solid carbon and gaseous hydrogen and oxygen. Thus, in the case of alcohol, experiment shows that when 1 grm. of alcohol is burnt to CO_2 and H_2O, thus—

$$C_2H_6O+3O_2=2CO_2+3H_2O,$$

there are developed about 7000 calories, or on burning 46 grms. 322,000 are developed, whilst on burning the carbon present and the hydrogen separately there would be developed by the first $24\times8000=192{,}000$ calories, and by the second $6\times34{,}000=204{,}000$.

Hence it results that the synthesis of alcohol from 24 grms. of solid carbon, 6 of gaseous hydrogen, and 16 of gaseous oxygen must be accompanied by an evolution of heat to the extent of $204{,}000+192{,}000-322{,}000=74{,}000$ calories.

Similarly, the synthesis of 32 grms. of methylic alcohol from 12 carbon, 4 hydrogen, and 1 oxygen is accompanied by the evolution of—

$$12\times8000+4\times34{,}000-32\times5300=62{,}400,$$

where 5300 is the heat of combustion of 1 grm. of methylic alcohol. Hence the transformation of 32 grms. of methylic alcohol into 46 of ethylic alcohol, by adding on 12 grms. of solid carbon and 2 of gaseous hydrogen (symbolically represented by the replacement of H by CH_3) would be accompanied by an evolution of $74{,}000-62{,}400=11{,}600$ calories. Could this replacement, or rather addition, be effected by a single reaction at the ordinary temperature,

so that we should start with methylic alcohol, carbon, and hydrogen, and end with ethylic alcohol, this amount of heat evolution could be observed by means of the calorimeter. Using Thomsen's symbols, this synthesis would be written CH_4O,C,H_2.

In order to make results of this sort comparable a uniform standard of comparison is necessary. The calculations that I have made, based on a particular standard (*Phil. Mag.*, December, 1874), have given the following results, the standard being such that the bodies supposed to be synthesised from C, H, and O are regarded as vaporous at a temperature $t°$ (which for convenience is taken as 100°) under the constant pressure of 760 m.m., the constituent carbon being solid, and the oxygen and hydrogen gaseous, and previously reduced to the same volume at $t°$ and 760 m.m. as would be occupied by the synthesised vapour: so that the calculation amounts to this:—A given quantity of solid carbon and compressed hydrogen and oxygen are supposed to be suddenly transformed into the vapour of a compound occupying the same bulk, and the heat developed in the transformation is measured. By comparing together the amounts of heat development in various such cases, reckoned on equal bulks of vapour (for convenience on such a bulk as would, if reduced to 0 and 760 by the ordinary rules, occupy 22·32 ,litres, a bulk which for convenience may be spoken of as 2 *metropneums*, and the weight of which is 1 *metrogramme*, *vide Phil. Mag.*, *loc. cit. supra**), information is gained as to the amount of heat absorption or evolution that would accompany the "operations" (as B. Brodie terms them), of conferring upon a given bulk of space weight, and communicating to it the properties characteristic of one kind of matter (*e.g.*, methylic alcohol vapour), and of further communicating to it additional weight and other properties (*e.g.*, ethylic alcohol vapour). That is, the operations in the examples taken are symbolised by firstly synthesising $CH_3.OH$, and then transforming this into $CH_3.CH_2.OH$, this latter operation being one which may be conveniently termed *hydrocarbonous methylation*, to distinguish it from *hydroxylic methylation*, which would be represented by the transformation of $CH_3.OH$ into $CH_3.O.CH_3$.

From the calculations of this kind that I have made, based on the experimental data furnished by Andrews, Favre and Silberman, Regnault, Kopp, J. Thomsen, and others, it results, amongst other things, that:—

(1.) The operation of hydrocarbonous methylation is always accompanied by heat evolution.
(2.) The operation of hydroxylic methylation is always accompanied by heat absorption.
(3.) Conversion of a group—CH_2—into the group —CO—is accompanied by heat evolution.
(4.) Any operation causing heat evolution gives rise to a body of higher boiling-point than the one operated on, and *vice versa*.

As an example of (1) and (4) the members of all true homologous series (such as methylic and ethylic, &c., alcohols) *boil at gradually increasing temperatures*, and the formation of each member by methylating the previous one *gives rise to heat evolution*. As an example of (2) and (4), the formation of a methylic ether of an alcohol or acid *gives rise to heat absorption, and to lowering of boiling-point*. Water on its successive conversion into methylic alcohol and methylic ether affords a good example of this, each hydroxylic methylation absorbing heat and lowering the boiling-point; whilst conversion of methylic alcohol into ethylic (hydrocarbonous methylation) evolves heat and raises the boiling-point. Conversion of hydrogen into marsh-gas evolves heat, *ergo*, marsh-gas should have a higher boiling-point, *i.e.*, be more readily condensable to the liquid state.

In the case of (3) and (4), an acid is formed from a primary alcohol with *evolution of heat and great increase in boiling-point*. Conversion of water into free oxygen by replacement of H_2 by O, however, is accompanied by heat absorption and lowering of boiling-point, so that replacement of H_2 by O does not necessarily always evolve heat, unless associated with carbon, just as hydrocarbonous and hydroxylic methylation are different.

The third and chief class of experiments on which I have worked recently, and am still engaged, is that of the carrying out into practice and further development of the electrochemical method of Joule, Woods, and Sir W. Thomson, referred to above. This method is based on the following principles:—Faraday showed that (with moderately strong currents, at all events) the passage of a given quantity of electricity through an electrolyte always produces an equivalent amount of decomposition no matter what the nature of the electrolyte,* so that the weight of matter decomposed n grms., say, varies as Q, the quantity of electricity passing, and as a the equivalent of the body; whence n varies as Qa, and hence $n = Q\,a \times \chi$, where χ is a constant independent of the equivalent or of the quantity of electricity.

Now the total work done during the passage of a quantity of electricity Q from one point to another, the potentials of which differ by E, is E Q. Suppose that in the electrolysis all the work is done as chemical decomposition and none as heat evolution; then if H is the heat evolved during the synthesis of 1 grm. of electrolyte from the products of decomposition, n H J represents the work done, whence—

$$n\,\mathrm{H\,J} = \mathrm{E\,Q} = \mathrm{E}\frac{n}{a\chi},$$

or,

$$\mathrm{E} = \mathrm{H}\,a\chi\,\mathrm{J} = \mathrm{H_1}\,\chi\,\mathrm{J}.$$

Where H_1 is the heat evolved during the synthesis of a grms. (1 grm. equivalent) of electrolyte. So that the energy corresponding to the synthesis of a grm. equivalent of electrolyte may be expressed either by H_1 J, or by $\frac{E}{\chi}$: that is, just as J represents a factor by which a heat value must be multiplied to obtain the corresponding energy value, so $\frac{1}{\chi}$ represents an analogous factor by which an E.M.F. value must be multiplied to obtain the corresponding energy value: or, in other words, just as work—*i.e.*, affinity—may be expressed in terms of heat units, so it may also be expressed in terms of E.M.F., the first value being transferable into the other by multiplication by the factor χ J. To χ I propose to apply the term *electro-chemical constant*; its numerical value on the C.G.S. system, electromagnetic units, is 0·000105, that of J being 41,500,000, or $41{\cdot}5 \times 10^6$ (Joule's water-friction value). That is, one heat unit (grm. of water raised 1°) represents $41{\cdot}5 \times 10^6$ C.G.S. work units = 41·5 megalergs: whilst one C.G.S. work unit represents 0·000105 C.G.S. units of E.M.F. equal to $1{\cdot}05 \times 10^{-12}$ volts. (1 volt. = 10^8 C.G.S. unit): so that 1 heat unit corresponds to $41{\cdot}5 \times 10^6 \times 0{\cdot}000105 = 4357{\cdot}5$ C.G.S. units of E.M.F., or to 0·000043575 volt.; and 1 volt. corresponds to 10^8 C.G.S. E.M.F. units—

$$= \frac{10^8}{41{\cdot}5 \times 10^6 \times 0{\cdot}000105} = 22949 \text{ heat units.}$$

* The term "metropneum" is used to indicate the particular value of the expression—

$$11160 \times \frac{273+t}{273} \times \frac{760}{p}$$

for any given temperature t and pressure p, representing the bulk in cubic centimetres that 1 grm. of hydrogen would occupy at that pressure and temperature. The term "metrogramme," representing the weight in grms. of two metropneums of the particular vapour referred to, hence indicates more conveniently the mass sometimes referred to as a "gramme-molecule," or as the "weight of two volumes of vapour."—*Vide* also Chemical News, July 18, 1873, p. 25.

* Various experimenters—*e.g.*, Faraday himself and Favre—have considered it possible for very feeble currents of electricity to traverse an electrolyte without producing decomposition; *i.e.*, they supposed that conduction without electrolysis can take place. This has been denied by others. I have recently rigorously examined the point, with the result of finding that *a given quantity of electricity passing always does produce the same equivalent amount of decomposition no matter how slowly it passes*, *i.e.*, no matter how minute the current is made.

In actual practice a current never does decompose an electrolyte without also developing heat; but if this heat be estimated by a calorimeter and called h, the total work done in passing between two points of potential difference, E, during the decomposition of a grm. equivalent of substance will be—

$$\frac{E}{\chi} = (H_1 + h)J,$$

whence $H_1 \chi J = E - h\chi J$. If, then, e be the E.M.F. representing the chemical work done during electrolysis—

$$e = H_1 \chi J = E - h\chi J.$$

Hence the affinity between the final products of an electrolyte (*i.e.*, the work done in resolving it into these final products) is readily determinable by determining the difference of potential E subsisting between the electrodes, and the heat evolved as such, h, during electrolysis of a grm. equivalent. In this way I have found (in conjunction with Mr. Rennie) that the affinity of oxygen and hydrogen gases to form liquid water at 15° is almost exactly 1·5 volts.

It is noticeable that the accuracy of this determination depends on the accuracy with which J is measured, and on that with which the electrical standards from which E is deduced are determined, that is, finally, on the determination of the B.A. unit of resistance. When Joule's water-friction value for J is taken, and the B.A. unit, there is found to be a discrepancy of about 1·5 to 2 per cent between the results as to affinity of H and O in water got by the electrolytic method and by direct combination; whilst the two results agree absolutely if the B.A. unit is supposed to be 1·5 to 2 per cent in excess of the true value through errors unavoidably made during its determination; and hence our experiments coincide with those of Joule and other observers, from whose work it results that if Joule's water-friction value for J be exact, the B.A. unit is really too large to the extent of 1·5 to 2 per cent. On the other hand, certain other observers' work indicates that the true value of J is somewhat higher than Joule's water-friction value, and that the B.A. unit is undervalued, not over estimated; whence fresh authoritative determinations (of the B.A. unit especially) are desirable.

The amount of heat, h, which is actually generated in an electrolytic cell depends upon two things: firstly, the amount of resistance, R, which is exerted by the electrolytic fluid, the effect of which is to cause the development of a quantity of heat equivalent to an amount of work expressed by C^2Rt (C = current, t = time in seconds during which it flows), in accordance with the law established by Joule and known by his name: and, secondly, the heat that is generated by secondary changes that ensue in the voltaic cell. The first quantity can readily be determined; so that finally the heat corresponding to the secondary changes is known (in terms of E.M.F.) by subtracting from E (the difference of potential between the electrodes) the value of e (the E.M.F. representing the work done in breaking up the compound into the final products), and also the E.M.F. representing C^2Rt, that is CR (since $Q = Ct$); that is, if e' be the E.M.F. representing the work done by secondary changes,—

$$e' = E - (e + CR), \text{ or}$$
$$e + e' = E - CR.$$

Now the quantity $e + e'$ is what is generally spoken of by physicists as the "Counter E.M.F. set up during electrolysis," or sometimes as "polarisation" (which latter term, however, is often also used in other senses), and admits of easy measurement by electrical means, so that by means of this measurement, combined with the determination of e (either by direct synthesis and measurement of heat evolved, or by the electro-chemical method just described), the value of e' can be determined.

All existing data show that the value of e' is variable with the conditions of the experiment. I am engaged in studying the effects of the variations produced by altering the current strength, the size of the electrodes, their material, the strength and nature of the electrolytic fluid, the temperature, &c.; and as the result of my own experiments at present made (not yet published), and those of previous investigators, am led to the following general theorem.

When a voltaic current is made to cause electrolysis, it would, were no interfering causes at work, split up the electrolyte into certain definite primary (nascent) products of such a nature as to evolve heat during their transformation into the final or secondary products (possibly into free atoms in the first instance, which would unite by a secondary action into molecules), so that a constant E.M.F. would be requisite to decompose the body into the nascent products, the numerical value of which would exceed the E.M.F. requisite to decompose it into the final products.

But, owing to the attractive action exerted by the electrodes, the products of electrolysis are more or less condensed, and in consequence the end result of the electrolysis is to decompose the electrolyte only partially into the nascent products, the remainder being evolved in a condensed form; in the case of a solid product in the form of the ultimate resulting solid modification; in the case of a gas into a quasi-liquefied or quasi-solidified form, such as that exhibited by the film of gas condensed on a surface by surface attraction or occlusion (the energy of which condensation is very considerable). Finally, therefore, the E.M.F. $e + e'$ actually requisite to break up the electrolyte is expressed by the formula, $e + e' = E_2 - n(H_1 + h_1)\chi J$, where H_1 is the heat evolved in transforming a grm. equivalent of nascent products into the ultimate products, and h_1 that evolved in the condensation of a grm. equivalent of the ultimate products (when gaseous) into the quasi-liquefied form, n being the fraction of the total products (viewed as 1) which is not developed in the nascent state, but is in the condensed form, and E_2 the value which $e + e'$ would have, were all the products evolved nascent, and consequently $= e + H_1\chi J$. Hence, the expression—

$$e + e' = E_2 - n(H_1 + h_1)\chi J$$

may be written—

$$e + e' = e + H_1\chi J - n(H_1 + h_1)\chi J,$$

whence—

$$e' = [(1 - n)H_1 - nh_1]\chi J,$$

the superior limit of e' (when $n = 0$) being $H_1\chi J$, and the inferior limit (when $n = 1$) being $-h_1\chi J$, and hence being 0 in the case of a solid product, when $h_1 = 0$. When h_1 is not $= 0$, *i.e.*, when gaseous products are evolved (such as oxygen, hydrogen, or both together as when water is decomposed), any, the smallest, rate of flow of electricity will set up a "polarisation," of amount capable of being reduced indefinitely, near to 0, by reducing the current sufficiently; and hence it results that the value of e', which is then more nearly at the lower limit than it can be under any other circumstances, must then approach indefinitely near to $-e$, so that at the actual limit e' is at least as great numerically as e; that is, the degree of energy expended in condensing the evolved gases to the quasi-liquefied or quasi-solidified form is as great as, if not greater than, the energy requisite to break up the electrolyte into the final products. Thus, in the case of water the sum of the energy of condensation of oxygen and hydrogen jointly on non-oxidisable electrodes (carbon, gold, Pt, &c.) is at least equal to that represented by 34,000 calories. In the case of copper sulphate where oxygen is the only gas evolved, the energy of condensation of the oxygen on Pt is apparently not less than that represented by about 28,000 calories, the heat that would be evolved during formation of a grm. equivalent of $CuSO_4$,aq from Cu, gaseous oxygen, and dilute H_2SO_4.

It is impossible to determine directly the value of e' at the other higher limit when $n = 0$; but its value can be approximately determined by a method, the principle of which is the same as that used by Crova in his experiments on "polarisation," viz., by plotting as a curve the corresponding values of current and "polarisation" obtained in a great many instances, calculating the equation

to the curve (a logarithmic one), and thence deducing the limiting value of the ordinate when the abscissa becomes infinite. To do this accurately requires an enormous amount of laborious work in order to overcome difficulties and avoid sources of error. The first rough approximation in this direction that I have obtained (conjointly with Mr. Rennie), indicates that the highest value of e' for water is at least as great as e, *i.e.*, that the energy requisite to convert 1 grm. of ordinary hydrogen and 8 of ordinary oxygen gases jointly into the allotropic modifications or "nascent forms" of these bodies, in which they are primarily evolved by electrolysis, is at least 34,000 calories, of which probably the major half is due to the hydrogen. Admitting that the "nascent forms" are separate atoms, and the final products molecules, it results that the heat development in transforming atoms of hydrogen into molecules thereof, together with that in transforming atoms of oxygen into molecules of oxygen, is not less than the heat developed during the union of these molecules of H and O to form molecules of liquid water.

INTRODUCTORY LECTURE
TO THE
COURSE OF METALLURGY,
AT THE
ROYAL SCHOOL OF MINES.

SESSION 1880-81.

By W. CHANDLER ROBERTS, F.R.S.,
Associate of the Royal School of Mines, Lecturer on Metallurgy in the Royal School of Mines, Chemist of the Mint, One of the Secretaries of the Physical Society of London.

THE distinguished metallurgist who has held this lecturership since the foundation of the Royal School of Mines concluded the introductory lecture he delivered more than a quarter of a century ago* by pointing out, to the students who were then beginning their course, that "in proportion to the success with which the metallurgic art is practised in this country, will the interests of the whole population, directly or indirectly, in no inconsiderable degree be promoted." This is a fact that none of his students are likely to forget.

Looking back on the actual advance of this country during the past thirty years, and remembering that the success with which any manufacturing art is practised must bear a direct relation to the way in which it is taught, we cannot but feel how greatly this development of metallurgical knowledge must have been influenced by Dr. Percy's labours. During this period the conditions under which metallurgy is practised have changed considerably; for the field of knowledge has so widely extended, the scale on which operations are conducted is now so great, and the mechanical appliances they involve are so varied and complicated, that while the interest of our subject is deepened its difficulty is gravely increased.

On the other hand, the preliminary training of the students before entering the school has much improved, although it still falls short of that required on the Continent—in France, for instance, where admission to the higher Mining Schools, such as the Ecole des Mines, is only granted to those who have either passed through the Ecole Polytechnique, graduated in science, or have passed a rigorous examination. While not advocating a too comprehensive preliminary training, I am none the less glad to see from the class lists that I am fortunate in having to lecture to students, many of whom have already distinguished themselves in chemistry, physics, and mechanics.

* *Records of the School of Mines*, vol. i., pt. 1 (1852), p. 127.

In turning to the history of metallurgy, more especially in its relation to chemical science, it is easy to be led away by the charm of the antiquarian riches of our subject into devoting too much time to this kind of literary research: I may remind you, however, that much of what is both interesting and full of suggestion, even at the present day, is to be found buried in the treatises by the old writers whose work we inherit and continue.

Primitive metallurgical processes are referred to in some of the oldest known historical records; naturally, therefore, the development of metallurgy as a science must have been long preceded by its practice as an art, an art for which a place has even been claimed among the religious systems of antiquity.* The earlier literature of the subject consists mainly of descriptions of processes; but it is well known that chemistry was to a great extent built up on a metallurgic basis, and Black's singularly advanced definition of Chemistry as the "effects produced by heat and mixture"† might well be applied to Metallurgy. The library of Leyden contains a papyrus which has been described by M. Reuvens,‡, and is considered by Kopp§ to be the oldest known chemical MS., its date being possibly as early as A.D. 200. It treats generally of metallurgical matters, and the purification of gold and silver is frequently mentioned. But of all the phenomena of our subject probably none have more contributed to advance the science of chemistry than those bearing upon the relations between oxygen and lead; indeed the interest attaching to the mutual behaviour of these two elements is so great that I propose devoting a few minutes to its consideration, more especially as I am anxious to indicate the influence of an ancient process on the scientific views of the present day.

When lead is melted with free access of air, a readily fusible substance forms on its surface. This substance may be allowed to flow away, or, if the metal is contained in a suitable porous receptacle, the fusible oxide sinks into this containing vessel; in either case the oxidation of the lead affords a means of separating it from precious or inoxidisable metals if any were originally present in the lead. The above fact has been known from remote antiquity, and the early Jewish writers allude to it as old and well known. They clearly show, for instance, that lead can be removed from silver by being "consumed of the fire," while the silver is not affected. That the Greeks knew and practised the method is abundantly proved, if only by certain specimens of gold and silver now in the adjoining museum, which were recently discovered by Dr. Schliemann. The Arabians investigated the subject; for passing to Geber,‖ the greatest of the early chemists (he died in 777), we find a remarkable account of cupellation; he also describes the conversion of lead into a fine powder by calcination with much clearness, and he noticed the fact that after calcination the mass has "acquired a new weight in the operation." I think his subsequent observations on the reduction of altered metals from their "calxes" show that he knew the weight to be increased: in any case it is interesting to observe that his work was, in a sense, quantitative. He, moreover, was cognisant of the fact that two different substances may be produced by heating lead in air, and he assumed that "in the fire of calcination a fugitive and inflammable substance is abolished." The alchemists refer continually to the subject, and "deliver themselves,"—as Roger Bacon said, in his "Speculum Alchimæ,"—"in the enigmas and riddles with which they clouded and left shadowed to us the most noble science." In the middle of the sixteenth century the truly accomplished metallurgist Biringuccio,¶ con-

* Rossignol, "Les Métaux dans l'Antiquité" (1863).
† Lectures by Joseph Black, M.D., vol. i., p. 8 (Edin., 1803).
‡ Reuvens, "Lettres à M. Letronne" (Leide, 1830), quoted by Prof. Ferguson in an Address to the Glasgow Phil. Soc. (1876), p. 19.
§ *Beiträge zur Geschichte der Chemie*, 1869.
‖ The Works of Geber, translated by R. Russell (1686), pp. 74, 78, 220, 234.
¶ "Pirotechnia" (Venegia, 1540), translated into French by T. Vincent (Rouen, 1627), p. 41.

temporary of Paracelsus and Agricola, seems to have been specially attracted by the phenomenon in question, and he remarks :—"If we had not lead we should work in vain for the precious metals, for without its aid we could not extract gold or silver from the stones containing them . . . The alchemists also," he said, "make use of it in their operations, calcining it by itself or with other substances; but," he goes on to observe, "the calcination, conducted in a reverberatory furnace is accompanied by a marvellous effect, the result of which should not be passed by in silence; for lead thus treated increases 10 per cent in weight, and, considering that most things are consumed in the fire, it is remarkable that the weight of lead is increased and not diminished." Although he subsequently gives evidence of much accurate knowledge of practical metallurgy, his views as to this particular phenomenon were hardly in advance of Geber's; but we may claim Biringuccio as an early metallurgist, who knew the facts, and recognised that they were theoretically important. It was not until nearly a century later (1630) that a French chemist, Jean Rey,* stated that the increase in weight came from the air. The problem attracted much attention in England; and it is not a little interesting that among the very first experiments recorded by our own Royal Society is a metallurgical series relating to the weight of lead increased in the fire on the "copels" at the assay office in the Tower, the account being brought in by Lord Brouncker in February, 1661.† Subsequently, in 1669, John Mayo showed that the increase in weight of calcined metals was due to a "spiritus" from the air.‡ Boyle heated lead in a small retort,§ and attributed the increase in weight, as Lemery also did,‖ to his having "arrested and weighed igneous corpuscles."¶

I need hardly point out how important this calcination of lead was considered by those who defended the Phlogistic theory in regard to chemical change, a theory which, for more than a century, exerted so profound an influence on scientific thought; as, however, we owe it to a metallurgist, Becher, I cannot dismiss it without a few words. [Here is the book in which his views were first embodied, the "Physica Subterranea" (1669), and here is his other celebrated work, the "Alphabethum Minerale" (1682).]

According to his still more famous pupil Stahl, the litharge produced by the prolonged calcination of lead in air is lead deprived of its phlogiston; but he and his followers were indifferent to the fact that when lead is burnt the weight of the resulting mass is greater than that of the original metal, and were content to insist that the burnt lead had lost its inflammable principle—that is, Phlogiston. Lavoisier, as we know, overthrew the old phlogistic theory by showing that a chemical combination takes place, resulting in an augmentation of weight which represents the exact weight of the gaseous body added. At the same time it should be remembered that the phlogistic chemists made a great step in advance, as was admitted by J. R. Mayer in his memoir on the mechanical theory of heat** ; and Odling, discussing the experiments on the oxidation of lead, has more recently pointed out* that an error has arisen in consequence of the same word being used in a different sense at different periods of time: chemists, in fact, now substitute the words potential energy for phlogiston; or, as Dr. Crum-Brown has well observed†, we recognise "that no compound contains the substances from which it was produced, but that it contains them *minus* something. We now know what this something is, and can give it the more appropriate name of potential energy; but there can be no doubt that this is what the chemists of the seventeenth century meant when they spoke of phlogiston." It will thus be evident that the main aim of chemical investigation down to the end of last century was the explanation of calcination, combustion, or oxidation, and that lead was especially useful in solving the problem.

I might, perhaps, add that the *absorption* of oxygen by molten litharge has furnished M. Ste.-Claire Deville,‡ a physicist and metallurgist, with an important step in the argument as to dissociation, and thus connects the history of the metal with the great advance on the borderland of chemistry and physics in modern times, to which I shall constantly refer.

The above remarks will, I trust, be sufficient to show that conclusions of the utmost importance in the history of chemical theory were based on a very ancient metallurgical process; but I have also selected lead as an illustration, because, in the gradual development of the knowledge derived in the first instance from its metallurgy, there is much that is typical of the mutual relation of theory and practice that still prevails.

When Dr. Percy began his teaching he considered at some length the kind of assistance that other sciences might be expected to render our subject, considered as a manufacturing art; and this at the time was necessary for two reasons:§ first, because he was "able to adduce from his own observation several striking cases in illustration of the advantage of the application of science to practical metallurgy; and, second, because the practice of metallurgy, so far as relates to magnitude of operation, having been developed to an unparalleled extent in this country in the absence of specific public instruction on the subject, it was necessary to justify the providing of such instruction."

The absence of accurate knowledge on the part of those engaged in metallurgy was lamented as long ago as 1700, in an "Inaugural Dissertation of Pyrotechnical Metallurgy," delivered, on the 25th of March of that year, in the University of Magdeburg; no less a person than the great supporter of the theory of Phlogiston, George Ernest Stahl, presided, and the lecturer was Fritschius, who said‖—"If in any part of the working of metals there is commonly more owing to experience than reason, truly it is in fusion or melting; . . . nevertheless if the reason be asked why the business succeedeth well in this way, but in another doth not succeed at all, you have no solid answer, but only that most general one, which is most commonly false, viz., that one fire is stronger and another weaker, and so insufficient." It is just a century since Bishop Watson, Professor of Chemistry and Regius Professor of Divinity in the University of Cambridge, pointed out¶ that "the improvement of metallurgy, and other mechanic arts dependent on chemistry, might best be made by public establishment of an Academy, the labours of which should be destined to that particular purpose;" and the School of Mines, thus foreshadowed, was established in 1851, its principal object being to "discipline the students thoroughly in the principles of those sciences upon which the operations of the miner and metallurgist depend."

* "Essays de Jean Rey (reprinted in Paris, 1777), p. 64.
† "MS. Register Book of the Royal Society."
‡ *Tractatus quinque Medico-Physici*, p. 25 *et seq* (Oxonii, 1674).
§ "Collected Works," vol. iii. (1744), p. 346.
‖ *Cours de Chymie* (1675), 2nd English Edition (1686), p. 107.
¶ I am indebted to my friend, Prof. Ferguson, M.A., of the University of Glasgow, whose eminence as a historian of chemistry is well known, for several interesting additional facts in connection with the calcination of metals. After referring to Eck (1489), Glauber (1651), and others, he writes:—"One of the most curious passages I know is in the 'Hippocrates Chemicus' of Otto Tachen, or Tachenious, a German who lived at Venice and published his book there in 1666. He describes how lead, when burnt to minium, increases in weight. This incease he ascribes to a substance of acid character in the wood used for burning, and then, by a very curious course of argument, based on the saponifying powers of litharge, makes out that lead is of the nature of or contains an alkali, which combines with the 'occult acid of the fat.' This is a curious anticipation of a very modern classification which brings lead into relationship with the alkalies and alkaline earths, as well as of Chevreul's investigations."
** "Bemerkungen über die Kräfte der unbele Natur," *Liebig's Ann.*, xlii. (1842), p. 233.

* *Proc. Roy. Inst.* (1871), vol. vi., p. 323.
† *Edin. Roy. Soc. Proc.*, v. (1866), p. 328.
‡ "Leçons sur la Dissociation," 1864.
§ *Records of the School of Mines*, vol. i., pt. 1 (1852), p. 123.
‖ "Pyrotechnical Metallurgy," by J. C. Fritschius, of Schwartsburg (translated in 1704), p. 203.
¶ "Chemical Essays," 2nd edition (1782), vol. i., p. 47.

Our honoured founder, Sir Henry de la Beche, in his Address at the opening of the School of Mines,* said:—"We still too frequently hear of practical knowledge, as if in a certain sense opposed to a scientific method of accounting for it, and as if experience, without that advantage, was more trustworthy than the like experience with it." Such remarks might, with truth, be made at the present day; but it should nevertheless be remembered that many metallurgical works are successfully conducted in this country by so-called practical men. I do not mean the kind of man so forcibly described by Mr. Bramwell† as one "whose wisdom consists in standing by, seeing, but not investigating, the new discoveries which are taking place around him . . . . the aim and object of such a man being to ensure that he should never make a mistake by embarking his capital or his time in that which has not been proved by men of large hearts and large intelligence;" nor do I mean the man who accepts no rule but the rule of thumb; but I do mean practical men possessing technical knowledge of a high order, whose careful observation enables them to use the results of past experience in dealing with circumstances and conditions analogous to those they have met with before, and with which long practice has made them familiar. It would be difficult to overrate the value and importance of such knowledge as theirs, and, when we remember the scale on which smelting and other operations are carried on, it will be obvious that this kind of knowledge can only be gained in the works, and not in the laboratory or lecture-room; for, however careful the metallurgical teaching here may be, it can only be practical in a limited sense. At the same time it must be borne in mind that a man trained to scientific methods starts with the enormous advantage of being able to deal with circumstances and conditions that are new to him, and with which, therefore, he cannot be said to be "familiar." The technical skill that time and opportunity can alone give him will then rest on a solid basis. I repeat, however, that I am anxious at the outset to guard against undervaluing the teaching of experience unaided by reasoning that we should recognise as scientific; for it is only necessary to witness such operations as the roasting of a large mass of ore on the bed of a furnace, or the forging of many tons of iron under a steam-hammer, to appreciate the value of the subtle skill of sight and touch on which success depends.

I have thus ventured to trace the relation between scientific and technical men, as hitherto there have been misunderstandings on both sides, or, as Dr. Williamson so well observes‡:—"Men of detail do not sufficiently appreciate the value and usefulness of ideas, or of general principles; and men of science, who learn to understand and control things more and more by the aid of the laws of nature, are apt to expect that all improvements will result from the development and extension of their scientific methods of research, and not to do justice to the empirical considerations of practical expediency, which are so essential to the realisation of industrial success in the imperfect state of our scientific knowledge."

While it is no longer necessary to justify the scientific teaching of metallurgy, as Dr. Percy did, it is as important as ever that the true relation of theory and practice should be clearly understood. It rarely happens that a process can be transferred from the laboratory to the works without important modifications; and we must remember that metallurgy is a manufacturing art, and that, when the truth of a theory has been demonstrated, a dividend has to be earned; this would indeed often be difficult without the aid of the technical man. Practical men have, however, ceased to undervalue science, and the most practical body of men in the world, in the best sense of the term, the Iron-masters of this country, on whom its prosperity so largely depends, formed themselves ten years ago into an Iron and Steel Institute, many of the members of which possess high scientific attainments and are distinguished for scientific research.

Let us turn, then, to the advice given us by those who are accustomed to deal with metals on a large scale. Mr. I. Lowthian Bell stated in his address as President of the Institute in 1873*:—"If we would avoid the failure of what may be designated unscientific practice, or the failure of impracticable science, we must seek to combine commercial intelligence with a knowledge of those natural laws which form the only trustworthy groundwork of the complicated processes in which we are engaged."

Dr. Siemens† said in 1877:—"It is not many years since *practical* knowledge was regarded as the one thing requisite in an iron-smelter, whilst *theoretical* knowledge of the chemical and mechanical principles involved in the operations was viewed with considerable suspicion;" and he adds, with reference to the teaching of the School of Mines and of a general Technical University:—"But it must not be supposed that I would advocate any attempt at comprising in its curriculum a practical working of the processes which the student would have to direct in after-life. . . . . Let technical schools confine themselves to teaching those natural sciences which bear upon practice, but let practice itself be taught in the workshop and in the metallurgical establishment."

The President for 1879, Mr. E. Williams, a most eminently practical man, and one of the founders of the prosperity of the great Cleveland iron district, urged‡ "educated intellectual young men, who now hang listlessly about the professions, ... to break through the absurd old prejudice against seemingly rough work," in order that they may act as scientifically trained managers.

I have thus appealed to authorities, because my own practical work has been mainly confined to a limited branch of metallurgy. I say limited, for, although, on looking into the matter, I find, to my surprise, that I have during the last ten years been responsible for the fineness of 330 tons of gold and 740 tons of silver, this, though of a total value of 47 millions sterling, is a comparatively small bulk of metal, and the operations through which it passes are seldom complicated; but I am none the less convinced that in metallurgical works generally, as in a Mint, the work can only be efficiently conducted by taking advantage to the utmost extent of the aid that science has to offer, a Mint only differing from other works by the extraordinary care and vigilance which must be exercised to ensure accuracy and avoid loss in dealing with the precious metals. Even this difference is less marked than formerly, and, as attention to minute details is becoming more and more essential to the profitable conduct of works, my experience in this respect will be useful to you.

On the Continent, as is well known, the government inspectors and engineers are far more numerous than in this country, where both the extraction and utilisation of metals are left largely to private enterprise. One result of this official influence is that it enables students in the mining schools to visit and report on works as part of their educational course. I hope that it may be possible to arrange for systematic visits of students to manufactories in this country. I have already received courteous promises of aid from several owners, and the wide distribution of our own men throughout the country will doubtless help to render this easy.

As regards the actual training in the school, I believe that our utmost efforts should be devoted to giving the students a thorough acquaintance with scientific methods and metallurgical principles, furnishing them at the same time with as many well-ascertained *facts* as possible. Here I may, perhaps, be permitted to quote a few words

* *Records of the School of Mines*, vol. i., pt. 1 (1852), p. 20.
† "British Association Report, Brighton" (1872), p. 238.
‡ "A Plea for Pure Science" (Inaugural Lecture, University College, London, 1870).

* *Journal of the Iron and Steel Institute* (1873), No. 1, p. 12.
† *Ibid.* (1877), No. 1, p. 7.
‡ *Ibid.* (1879), No. 1, p. 24.

from Prof. Huxley's* address at Birmingham on Friday, as they bear so directly on our subject; he said, "What people call applied science is nothing but the application of pure science to particular classes of problems. It consists of deductions from those general principles, established by reasoning and observation, which constitute pure science. No one can safely make these deductions until he has a firm grasp of the principles; and he can obtain that grasp only by personal experience of the processes of observation and of reasoning on which they are founded."

In one important branch of metallurgy—assaying—the teaching in the School is thoroughly practical, and the operations you may in future be called upon to conduct will not differ from those taught in this laboratory. The teaching will, I am glad to say, be now specially entrusted to my friend Mr. Smith, the value of whose instruction, in my own case, I gratefully acknowledge.

It can hardly be questioned that, until the School of Mines was established, the metallurgical success and reputation of this country rested to a remarkable extent on the exceptional skill of its technical men. I think, therefore, we may be fairly asked to consider whether the metallurgical teaching of the School has been justified, and how far advance has been due to trained scientific thought.

(To be continued.)

CORRESPONDENCE.

ELECTRIC *VERSUS* GAS LIGHTING.

To the Editor of the Chemical News.

SIR,—In reading the very clear and comprehensive lecture on the subject of Electric Lighting (CHEMICAL NEWS, vol. xlii., p. 227), I was greatly pleased to find that so competent an authority as Mr. J. W. Swan is convinced of the fact that electric lighting by means of incandescent carbon is more economical than lighting by gas. In Mr. Swan's illustrations, however, I do not see that the original cost of the steam-engine (or gas-engine) and of the dynamo-electric machine has been taken into account. Besides the original cost of machines, there is the important matter of depreciation: the wear and tear of the current generators must be especially great. Further, the wages of the staff of engineers and workmen, and the cost of the distributing plant, will be no mean items. On page 231 Mr. Swan takes the gas at its price when delivered to the consumer; while the electric light is estimated to cost nothing more than the gas used by the engine. Probably when the above corrections have been made the cost of the electric light will still be less, or not more, than that of gas. If so, the days of gas lighting are clearly numbered; for—leaving out of consideration the greater beauty and whiteness of the light emitted by the incandescent carbon—the fact that it will neither heat the air of the room in which it is used, nor contaminate it by replacing its oxygen by the products of combustion, give the latter such an unquestionable and valuable superiority, that the education of the public only is necessary to bring it into general use.—I am, &c.,

C. B. CASWELL.

13, George Road, Edgbaston, Birmingham,
November 9, 1880.

THE SPECIFIC ROTATORY POWER OF CANE- AND INVERT-SUGAR.

To the Editor of the Chemical News:

SIR,—With your kind permission I intend ventilating the questions and points brought forward by Mr. Allen, as it seems to me not desirable that sugar chemists should accept such statements apodictically. In regard to the specific rotatory power of a substance dissolved in an inactive liquid we have to remember that $[\alpha]$ is not constant, and varies more or less with the number of active molecules in solution. It requires, therefore, a whole series of optical observations for different concentrations, and such have up to now been made only for cane-sugar (Tollens, Schmitz), for dextrose (Tollens), lactose (Meissl), and for milk-sugar (Hesse). All these observers applied sodium light for their experiments. In looking through the tabulated results of Tollens and Schmitz we find, as the nearest amounts to the normal weight for Soleil's saccharimeter:—

15·01 gr. made up to 100 c.c. at 20° C. = 19·94x° (Tollens), and 18·175 gr. made up to 100 c.c. at 20° C. = 24·13 (Schmitz).

If, then, we accept Broch's statement, that a quartz of 1 m.m. in thickness rotates the sodium light for 21·67x°, we may use the proportions—

$$19{\cdot}94 : 21{\cdot}67 = 15{\cdot}01 : (x = 16{\cdot}31) \text{ and}$$
$$24{\cdot}13 : 21{\cdot}67 = 18{\cdot}175 : (x = 16{\cdot}32),$$

and this answer shows very nearly the actual amount required as the normal weight for Soleil. Moreover, Schmitz has, from his own results and those obtained by Tollens, calculated a formula for the degree of concentration, viz., $C = 0{\cdot}75063\,a + 0{\cdot}0000766a^2$, and for $a = 21{\cdot}67$, C = 16·302 gr. in 100 c c. at 20° C. The difference between this number and 16·35 is therefore not very great, and the latter is certainly near enough for practical purposes. Besides, for scientific observations a whole number (like 10 grs.) is much more convenient.

Before proceeding with the next question, I may say that I did not take as a basis for my calculations the data given for the transition tint, because they are not precise enough. Biot states that 1 m.m. of quartz rotates 24x°, while Broch declares it to be 24·5x°; and as for the rotation caused by solutions of sugar, Montgolfier calculates—

$$(\alpha)_D : (\alpha)j = 1 : 1{\cdot}129,$$

while Weiss considers the right proportion (for solutions from 5 to 19 grs. in 100 c.c.) to be as 1 : 1·034. Now, even if we accept 24 as the proper angle, which is or was the concentration when obtaining $(\alpha)j = 73{\cdot}8$?

We may now consider the statements made concerning invert-sugar. Clerget found that 16·35 grs. of cane-sugar, after inversion and cooling to 0° C., deviate the light for −44 divisions of Soleil's scale. Tuchschmidt, by a series of careful observations, confirmed this (finding −44·16), and Casamajor merely repeated partly what Tuchschmidt has explained before him.

As 100 divisions of Soleil equal—

$$21{\cdot}67x^\circ,\ -44{\cdot}16d. = -9{\cdot}5693x^\circ,$$

and which rotation is caused by a layer of 200 m.m. of 17·21 grs. invert-sugar (derived from 16·35 grs. cane) in 100 c.c. Hence 17·21 grs. : 9·5695x° = 10 : (x = 5·560x°), and from this we obtain, by multiplying with 5, the specific rotation $(\alpha)_D = -27{\cdot}8$ at 0° C. and for our special concentration. But according to Clerget, as also Tuchschmidt, the rotation decreases steadily with the rise of temperature, and the latter observer shaped the respective law into the following formula:—$(\alpha)^t{}_D = -27{\cdot}8 + 0{\cdot}32\,t$; therefore, for t = 20° C. $(\alpha)_D$ equals −21·4, and for t = 14° C. $(\alpha)_D$ becomes −23·32.

Mr. Allen speaks also of the specific rotation of lævulose, and to calculate this we have to remember that, according to Tollens, $(\alpha)_D = 53$ for solutions of dextrose containing up to 14 grs. dissolved in 100 c.c. at 20° C. (Soxhlet considers it to be slightly less, viz., 52·5.) As invert-sugar consists of equal parts of dextrose and lævulose we have—

$$-\frac{L}{2} + \frac{D}{2} = -21{\cdot}4$$

and L = −95·8 = $(\alpha)_D$ at 20° C., and for a solution containing about 8·5 grms. in 100 c.c. For the temperature of 14° C. $(\alpha)_D$ is calculated to equal −99·64.

A series of exact observations of the rotation of lævulose have not yet been made, and as our knowledge of the optical properties of this sugar are incomplete, Mr. Allen cannot expect to find full or clear information about it in a "Dictionary" or a general treatise on chemistry.—I am, &c.,

J. Steiner.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 16, October 18, 1880.

Saccharine Matters Contained in the Fruit of the Coffee Tree.—M. Boussingault.—The author has operated upon 6·4 kilos. of alcohol, in which the ripe fruits had been brought over, and 9·030 kilos. of fruit taken out of the alcohol. He obtained a total yield of 92 grms. mannite, 364·4 grms. inverted sugar, and 98·6 grms. cane-sugar. He does not consider that the pulp of the coffee berry could be utilised as a source of alcohol.

Photophone of MM. Graham Bell and Sumner Tainter.—A. Breguet.—This paper cannot be reproduced without the accompanying illustration.

Spectroscopic Studies of the Sun, Conducted at the Observatory of Paris.—L. Thollon.—The author remarks that the sun has entered upon a period of activity, and he describes and figures certain luminous protuberances, to one of which he ascribes a height of more than 100,000 kilometres.

Vibratory Forms of the Circular Pellicles of Saposaccharic Liquid (Continuation).—C. Decharme.—The author, in this second portion of his memoir, treats of the position of the nodals for each system.

Presences of Cerium in the Coal Measures of the Basin of St. Etienne.—M. Mayençon.—The cerium, probably accompanied by didymium and lanthanum, was found in certain kidney-shaped nodules of iron-spar from the new mine of Ferouillat, near Béraudière.

Les Mondes, Revue Hebdomadaire des Sciences. No. 5, June 24, 1880.

Ultra-violet Rays.—J. L. Schönn.—The author gives the position of the ultra-violet rays of the spectra of cadmium, zinc, thallium, calcium, indium, magnesium, iron, and aluminium. His apparatus is well adapted for the study of absorption spectra; a column of water of 10 centimetres contained between two plates of quartz absorbs the greater part of the ultra-violet rays, whilst a block of very pure ice of 21 centimetres does not sensibly absorb the rays of cadmium in this portion of the spectrum.

Simple Method of Observing the Phenomena of Diffraction.—V. D. Vorak.—The rays reflected by a heliostat are concentrated by two lenses. In the focus is placed a diaphragm with a very small aperture, and the luminous glass is received on a screen. In this glass are placed the bodies whose shadows are to be studied.

Remarks on the Experiments of Mr. Crookes — Leonhard Weber.—For electrodes sealed into the glass the author substituted metallic armatures applied to the surface of an exhausted receiver and connected with the poles of an induction-coil. The only difference is that the currents, being alternately in a contrary direction, the effects indicated by Crookes at the negative pole were seen simultaneously at both poles with the same intensity.

New Air-Thermometer.—M. Miller.—The apparatus is constructed of an iron support fitted at its upper part with two tubulures, in which are fixed the two tubes of the manometer. The closed branch bears a thread of opaque glass, soldered in its side at the point where the large tube joins the connecting tube.

The Magnetic Apparatus of M. Edard.—Among other electric or magnetic appliances for the treatment of various diseases is mentioned a magnetic sand, which M. Edard imports from the Isle of Bourbon, and which has been subsequently found near Morbihan. Its application is said rapidly to revive diseased plants.

July 1, 1880.

At London, in Canada, there is said to be a girl possessing remarkable electric powers. On joining hands she can give a strong electric shock to fifteen or twenty persons, and she attracts the magnet. If she wishes to take up a knife the blade rushes to her hand, and a packet of needles folded up in paper hangs suspended from the ends of her fingers.

The Automatic Electric Lamp of M. Jamin.—The apparatus cannot be intelligibly described without the accompanying woodcut.

The Theory of the Battery.—M. Pellat.—A voltaic battery is the seat of electromotor forces, and it is a source of energy, but there is no necessary coincidence between the place of origin of these two quantities. The energy is due to the chemical activity, whilst the electromotor forces have their seat in the different contacts, especially those of dissimilar metals.

L'Orosi, Giornale di Chimica, Farmacia, e Scienze Affini. No. 2, 1880.

Giuseppe Orosi and his Works.—A biographical notice of an Italian chemist and pharmaceutist, from whose name this journal derives its puzzling title.

Reciprocal Relation between the Atomic Weights of the Elements and their Properties (Continued).—Dr. Dario Gibertini.—This extensive memoir may be regarded as a survey of the researches of Mendelejeff and Lothar Meyer.

Mean Composition of the Salt Waters and the Various Products of the Brine Springs of S. Leopoldo, near Volterra, and the Theory of the Preparation of Salt as there Practised (Continued).—Augusto Brasseur.—Not suitable for abstraction.

Characteristic Distinctions between Human Blood and that of other Animals.—Dr. Vincenzo Peset y Cervera.—On mixing the blood in question with a little bile there are formed in the mass, crystals not exceeding 0·003 metre in size. These crystals, according to the author, may be distinguished thus:—Those of man are right rectangular prisms; those of the horse, cubes; of the ox, rhombohedrons; of the sheep, rhombohedric tablets; those of the dog, rectangular prisms; those of the rabbit, tetrahedrons; of the squirrel, hexagonal tables; of the mouse, octahedrons; of common poultry, cubes modified at their angles, &c.

No. 3, 1880.

Giuseppe Orosi and his Works.—Dr. Angiolo Funaro.—A continuation of the biographical notice begun in the last number.

Thermic Equilibrium of Chemical Actions.—Dr. Donato Tommasi.—The author proposes the solution of the following problem:—When any compound such as can be oxidised and reduced is submitted to a chemical action, which is at the same time oxidising and reducing, in what manner will such compound behave, being in presence of two forces equal and opposite? The paper is to be continued, and does not appear to admit of useful abstraction.

Reciprocal Relations between the Atomic Weights of the Elements and their other Properties.—Dr. Dario Gibertini.—A continuation of the summary of the results of Mendelejeff and L. Meyer.

On some Causes which Hinder or Facilitate the Precipitation of Manganese Hydrate by Ammonia.—Giulio Puliti.—The author first examines the influence of ammoniacal salts in particular, and of ammonium chloride in particular. He finds that the precipitation of manganese from its solutions by means of ammonia may be partially or totally hindered by sal-ammoniac. Heat renders the sal-ammoniac more efficacious. In hot liquids the precipitation of manganese may be completely prevented if the metal meets with this reagent in the proportion of 1 : 150. He next examines the action of the metals which are capable of precipitation as hydrates by means of ammonia. He finds that iron, aluminium, and chrome facilitate the precipitation of manganese.

Mean Composition of the Salt Waters and the Various Products of the Brine Springs of S. Leopoldo, near Volterra.—Augusto Brasseur.—A continuation from the last number.

No. 4, 1880.

Giuseppe Orosi and his Works.—Dr. Angiolo Funaro.

Formation of Glucosides of a Complicated Structure.—Ugo Schiff.—From the synthesis of helicine effected by A. Michael, the author considers that some derivatives of this base may be considered as glucosides of three constituent groups, comparable in their constitution to phlorizine.

Thermic Equilibrium of Chemical Actions (Conclusion).—Dr. Donato Tommasi.—The author here answers the question raised in the first portion of his memoir :—When any substance is submitted to two chemical actions equal and opposite, the one which will evolve the greater number of calories will be produced in preference provided that the said reaction can be begun. Of two chemical reactions that which can be set up most easily will be produced by preference although it develops less heat than the other.

Reciprocal Relations between the Atomic Weights of the Elements and their other Properties.—Dr. Dario Gibertini-—A continuation from Nos. 2 and 3.

Mean Composition of the Salt Waters and other Products of the Brine Springs of S. Leopoldo, near Volterra.—Aug. Brasseur.—Continued from the last two numbers.

Utility of Boric Acid in Vinification.—Prof. A. Herzen.—The author maintains that boric acid does not hinder, but favours the alcoholic fermentation, and that it impedes the conversion of wine into vinegar.

Correspondenz-Blatt des Vereines Analytischer Chemiker.

No. 11, June 1, 1880.

Detection of Picric Acid in Beer.—Dr. H. Fleck.—The author evaporates 500 c.c. of the beer to a syrup, mixes with ten times its volume of absolute alcohol, filters off the precipitate, washing it as well as possible, and evaporating the alcoholic filtrate to dryness. The residue is extracted with water at a boil as often as the liquid becomes coloured, evaporates to dryness, and extracts the residue with ether. The ethereal extract contains the picric acid almost pure.

Quantitative Determination of Magenta in Coloured Meat.—Dr. H. Fleck.—A somewhat circumstantial process based upon the extraction of the colour with amylic alcohol.

Remarks on Mr. Tatlock's Letter.—G. Weiss.—The author considers the solvents recommended by Mr. Tatlock too powerful and unsafe. It is not sodium chloride which interferes with the accurate determination of potassa, but sodium, calcium, and magnesium sulphates.

Proportion of Water in Superphosphates (Concluded).—The author calls attention to the hygroscopic character of superphosphates made from guanos damaged by sea-water.

Value of Precipitated and Reverted Phosphates.—It is maintained that ferric and aluminic phosphates and bicalcic phosphates are equal in their effects to soluble phosphates containing equal quantities of phosphoric acid, and that upon sandy, peaty, calcareous, and marl soils the phosphoric acid soluble in citric acid is decidedly preferable in practice to that soluble in water. Raw Peruvian guano is generally preferable to such as has been rendered soluble with sulphuric acid. Ammonium carbonate, nitrate, and phosphate, and compounds analogous to ammonia, like certain nitrogenous and readily decomposable organic compounds are preferable to ammonium sulphate.

No. 12.

Use of Bromine in the Analysis of Sulphides.—E. Reichardt.—Bromine oxidises sulphur and sulphides very rapidly. Iron pyrites require to be very finely pulverised and a prolonged action is required. Copper pyrites are dissolved very rapidly if an excess of bromine is used, which is easily expelled by a gentle heat. The sample is placed in a small flask, covered with a little water, and the bromine is added. A gentle heat is sometimes necessary towards the end. One part of sulphur requires about 15 parts of bromine. Bromine water is especially adapted for destroying sulphuretted hydrogen and dissolving recently precipitated sulphides.

Behaviour of Carbonic Acid with Nessler's Reagent and Ammonia.—Th. Salzer.—A solution of acid ammonium carbonate or a dilute solution of sal-ammoniac mixed with water containing carbonic acid or with sodium bicarbonate, if mixed drop by drop with Nessler's reagent gives a yellow precipitate, which disappears on agitation without imparting the slightest colouration to the liquid. Not until the free carbonic acid has been saturated by the addition of caustic potassa or of an excess of the reagent, is a permanent yellow colouration produced.

No. 13.

Occurrence of Copper.—Dr. W. Hadelich.—The author has detected and determined copper in the soil of a churchyard, in portions of exhumed bodies, in wheat flour and in water.

Behaviour of Sugars with Solutions of Copper and Mercury.—F. Soxhlet.—From the *Journal f. Praktische Chemie.*

Detection of Phosphorus in Urine in a Case of Acute Poisoning.—It is recommended in cases of poisoning with phosphoric acid, to submit the urine to special examination.

Adulterations of Saffron.—A. Meyer.—Saffron is sophisticated with muscular fibre, the flowers of *Calendula officinalis*, safflower, *Crocus vernus*, *Punica granatum*, fragments of sanders-wood, glucose, glycerin, oil, chalk, and heavy-spar.

No. 14.

Determination of Carbonic Acid in Beer and Artificial Mineral Waters.—Dr. Bering.—This paper cannot be reproduced without the accompanying woodcut.

Determination of the Cinchona-Alkaloids by Polarisation.—Taken from Landolt's *Des Optische Drehungsvermögen Organischer Substanzen*, and not susceptible of useful abstraction.

Analysis of Certain American Tantalites.—W. J. Comstock.—From the Chemical News.

Determination of Theine in Tea.—Fifteen grms. tea are repeatedly extracted with boiling water till completely exhausted; the liquid is filtered, evaporated to the consistence of an extract, mixed with 2 grms. calcined magnesia and 5 grms. powdered glass and completely dried.

The residue is ground to powder, treated three or four times with 60 c.c. ether, and the ether is allowed to evaporate. The crystals of theine are re-dissolved in a little chloroform and the solution allowed to evaporate to dryness in a tared capsule.

Water in Superphosphates.—The author recommends that portions of 10 grms. should be heated for two hours in the water-bath in shallow porcelain capsules. He mentions that gypsum slowly loses three-fourths of its crystalline water even below 100°, and part of the remainder at temperatures little above 100°. Free phosphoric acid, if heated with gypsum, expels sulphuric acid even in the water-bath. Acid calcium phosphate is decomposed in the water-bath into free phosphoric acid and insoluble phosphates.

Chemisches Central-blatt.
No. 25, 1880.

Action of Cane-sugar on Silver Oxide.—E. Salkowski.—Cane-sugar produces the finest silver mirrors if a little soda-lye is added, though no inversion is occasioned.—*Zeit. f. Physiol. Chem.*, 4, 133.

MEETINGS FOR THE WEEK.

MONDAY, 22nd.—Medical, 8.30.
—— Royal Geographical, 8.30.
—— Society of Arts, 8. "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain," by A. H. Church, F.C.S.
TUESDAY, 23th.—Civil Engineers, 8.
—— Medical and Chirurgical, 8.30.
WEDNESDAY, 24.—Society of Arts, 8. "The Influence of Barry upon English Art," by J. Comyns Carr.
THURSDAY, 25th.—Royal, 4.30.
—— Philosophical Club, 6.30.
FRIDAY, 22th.—Quekett, 8.
—— Clinical, 8.30.
SATURDAY, 27th.—Physical, 3. "On Refraction Equivalents," by Dr. J. H. Gladstone, F.R.S. "On the rate of Loss of Light from Phosporescent Surfaces," by Lieut. L. Darwin, R.E. "On Minor Applications of Electromotors," W. H. Coffin.

TO CORRESPONDENTS.

Enquirer.—"Select Methods in Chemical Analysis," published by Longmans.

A. E. Scott.—The iridescence is probably due to sulphur present as an impurity; if, however, you will send a short note of particulars, we shall be able to say more about it. The iridescent colour seen on ancient glass admits of a satisfactory explanation.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m. daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

MOTTERSHEAD & CO.,

7, Exchange Street and 10, Half Moon Street,

MANCHESTER.

CHEMICAL & PHYSICAL APPARATUS,
BOTTLES, PURE CHEMICALS,
REAGENTS, STANDARD SOLUTIONS,
And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

GREENBANK ALKALI WORKS COMPANY (LIMITED),

ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums, or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{3}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

Carr's Patent Paint and Drug Mill.

Approved by some of the most eminent Chemists, and awarded the Silver Prize Medals of the Manchester and Liverpool, and the Middleton Agricultural Shows.

From Messrs. E. H. SMYTH & Co, 21, Duke Street, Edinburgh, and 69, Coleman Street, City, London.—The small Levigator Mill we recently got from you works most efficiently, and is a great economiser of time.

The chief feature in this machine is, that although it can be turned with ease by a boy, it has immense frictional power for levigating purposes. This is caused by the runner being driven at a much greater speed, but in the same direction, than the bowl. The surfaces being Minton ware, they are clean, smooth, and durable.

Testimonials on application.

£11 nett cash, delivered in Manchester.

The diameter of the bowl is 18 ins., and it and the runners are made of Minton ware. It is useful for Painters, Chemists, Grocers, and Cooks, for triturating and mixing Medicines, Vegetable Powders, Ointments, Paints, Sugar, Salt, Spices, Herbs, Meat for Potting, and will grind the COARSEST EMERY INTO A NEARLY IMPALPABLE POWDER in a few seconds. The pan can be tilted for emptying, as shown in the dotted lines; it can be worked by hand or power.

SOLE MAKERS—
W. H. BAILEY & Co., Albion Works, Salford, Manchester.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA.

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

THE CHEMICAL NEWS.

Vol. XLII. No. 1096.

ON THE ATOMIC WEIGHT OF BERYLLIUM.

By T. S. HUMPIDGE.

The correct number to be assigned to the weight of the atom of beryllium has been a matter of discussion amongst chemists for very many years. It has been held by many that some number about equal to 9·2 would be this correct value, and by others that it was rather represented by the number 13·2. According to the former school the formula of the only oxide which this metal forms becomes BeO, and according to the latter Be_2O_3. Berzelius, who is well known to have supported the latter view, based his opinions upon the analogies which the beryllium salts show rather with those of aluminium than with those of magnesium and the allied metals. As a matter of fact these analogies remain as strong as ever they were, but something more than analogy is required to definitely decide the atomic weight of an element. It is true that it has been shown that many compounds of beryllium might be written in a simpler manner if the formulæ BeO were accepted as that of its oxide.* But this was as little definite proof for the former supposition as the analogies discovered by Berselius were for the latter. It was therefore necessary to adapt some well-accepted method for the determination of the atomic weight. After Mitscherlich's theory of isomorphism became generally known endeavours were made to establish the correct formula of the beryllium compounds upon a more substantial basis. It had been already remarked that no double sulphate of beryllium and potassium or ammonium corresponding to the alums existed, as well as that beryllium sulphate did not crystallise with the sulphate of the magnesium group of metals. Debray showed,† on the other hand, that the crystalline form of beryllium oxide agreed equally well with that of zinc oxide and with that of alumina. The analysis of some specimens of noble beryl from Elba had also shown that they contained varying proportions of beryllium oxide and alumina, having at the same time the same general composition as ordinary beryl. With these contradictory results it was absolutely necessary to adopt some other means than isomorphism, in order to obtain a correct answer to the problem before us. For this purpose either the vapour density of some volatile compound of beryllium or the specific heat of the metal was required to be determined. As far as I am aware, no determination of the vapour density of those few compounds of beryllium which are volatile at a sufficiently low temperature (beryllium chloride, &c.)§ has been made, although Victor Meyer, has promised us such a determination. With regard to the second method, determinations of the specific heat of metallic beryllium by two different chemists, using entirely different methods for the preparation of the metal and different apparatus for the determination of its specific heat, have been made known within the last few years. The first of these was made by Professor Emerson Reynolds,‖ who prepared the metal from the chloride by means of sodium, using a calorimeter of his own devising for the determination of the specific heat. Prof. Reynolds, who employed platinum vessels for the reduction of the chloride, does not seem to have made any analysis of the metallic product which he obtained, to ascertain whether it fairly represented metallic beryllium. This method for the preparation of metallic beryllium was first employed by Wöhler,* and the metal obtained by him was apparently largely contaminated with platinum. That platinum vessels really are attacked during the reaction has been later confirmed by other investigators, *e.g.*, MM. Nilson and Pettersson, to whose work we have immediately to refer. Prof. Reynolds has also furnished us with no details of the other physical properties of his metal except that they agreed generally with those of the metal obtained by Debray; neither are details given of the manner in which the determinations of the specific heat were carried out. His determination of the value required gave 0·642, which, with an atomic weight of 9·2 for the metal would give an atomic heat of 5·9064, sufficiently near to the normal atomic heat (6) required by Dulong and Petit's law. The atomic weight of beryllium was therefore fixed by these experiments at 9·2. Almost immediately afterwards (1878) the second determination of the specific heat was made by MM. Nilson and Pettersson.† These investigators found at once that beryllium prepared by the reduction of the chloride in platinum vessels contained far too much of this metal to admit of its employment for a determination of its specific heat. They therefore employed another method for the preparation of the metal, which consisted in placing layers of molten beryllium chloride and sodium in a very thick iron tube, screwing up the tube, and heating to redness in a wind furnace. The beryllium was obtained as small partially fused crystals, some of them being 2 mm in diameter. The determiations of specific heat were made by Bunsen's ice-calorimeter, the only modification employed being that of Schuller and Wartha, by whom the external vessel of the instrument is covered with a thick layer of ice instead of being entirely immersed in pure snow. The metal prepared by these chemists was by no means pure, but they determined its exact composition and allowed for the impurities in their determinations. The percentage composition of the metal they obtained was :—

Beryllium	87·09
Beryllium oxide	9·84
Iron	2·08
Silica	0·99
	100·00

The specific heats of the two latter impurities had been previously accurately determined, and they made a fresh determination of that of beryllium oxide. Deducting then the relative specific heats of these impurities from that actually found, the true specific heat of beryllium was obtained. The mean of their experiments, carried out between 100° and 0°, gave the specific heat of the metal as 0·4079, which required the atomic weight of 13·8 to make the atomic heat 5·693—a number nearly approaching the normal value.

In attempting to form a judgment of these two determinations, which are entirely at variance with one another, simply upon their intrinsic methods, we must remember, firstly, that the metal prepared by Prof. Reynolds was in all probability very impure by admixture of platinum, which would tend to lower its specific heat, and that the apparatus he employed, though perhaps capable of accurate measurements, could scarcely be considered to be so exact as the ice-calorimeter of Bunsen. Secondly, it must not be forgotten that although M. Nilson was careful to determine the impurities which the metal prepared by him contained, and to allow for their relative specific heats, it is by no means clear that silica in combination in a silicate of beryllium, it must have existed in the impure metal, would really possess the same specific heat as when in the free state. Other things being equal, the method he employed for the determination of the specific heat, together with the precautions to which he attended so carefully,

* Audejeu, *Ann. d. Phys. u. Chem.*, lvi., 3.
† *Ann. de Chim. et d. Phys.*, xliv., 37.
§ *Phil. Mag.* [v] iii., 38.
‖ Organic compounds of beryllium, *e.g.*, Be_2Me_6, Be_2Et_6, &c., if they exist would probably be volatile bodies.

* *Pogg. Ann.*, xiii., 577.
† *Ber. Berichte*, xi., 381 ; *Wiedermann's Ann.*, iv., 554.

give his determination a decided preference over that of Prof. Reynolds to all unprejudiced minds.

Unfortunately the atomic weight of beryllium had been previously almost generally accepted as 9·2, and the determination of Reynolds came as a welcome confirmation to the common view. It had been especially noticed by Mendeleeff and Lothar Meyer, in the construction of periodic tables of the elements, that beryllium must possess the atomic weight of 9·2 and so be a divalent element, in which case it received a correct position in the tables and became the first member of the magnesium group; while if its atomic weight were 13·8 its position would fall between carbon (12) and nitrogen (14), which did not at all correspond to that of any other metallic element. The determination of Reynolds was therefore accepted without any attempt at criticism of the manner in which he arrived at his results. This was even the case at least in this country, after the publication of MM. Nilson and Pettersson's detailed account of their experiments.

As soon as Nilson had published his results he was at once attacked by Lothar Meyer, who attempted to show that the atomic weight of beryllium found by the former chemist was one entirely incompatible with the position of the element in the periodic series. As we have above remarked it would come between carbon and nitrogen, in which place no trivalent metallic element with a high melting-point could be introduced; and while attaching importance to the determinations of Nilson, he was of opinion that if these determinations were correct, the equivalent weight of beryllium must be lower then that generally accepted, and its atomic weight must lie between that of boron (11) and carbon (12). To this he added the observation that if the atomic heat of the oxygen contained in the beryllium oxide were compared with that contained in alumina, &c., the former, according to Nilson's atomic weight, would be much lower than it should be. The specific heat of the oxygen contained in an oxide is, as is well known, obtained by substracting from the molecular heat of the oxide the atomic heat of the metal which it contains; thus, if s represents the specific heats of the oxide and metal, m the molecular or atomic weight, and A the atomic heat of oxygen, then:—

	m.	s.	$s.m$.	A.
Al_2O_3 ..	102·8	0·217	22·3	
Al_2 ..	54·8	0·214	11·7	$\frac{10·6}{3} = 3·5$
			10·6	
Fe_2O_3 ..	160·0	0·168	26·9	
Fe_2 ..	112·2	0·114	12·7	$\frac{14·2}{3} = 4·7$
			14·2	
Be_2O_3 ...	75·6	0·247	18·7	
Be_2 ..	27·6	0·408	11·3	$\frac{7·4}{3} = 2·5$
			7·4	

And he concluded by pointing out that there might be some constant error running through all Nilson's determinations, which would tend to make all his results too low. The attack of Lothar Meyer was followed up by a remark from Brauner* that beryllium might belong to the same class of bodies as carbon, silicon, and boron, the atomic heats of which are too low to agree with Dulong and Petit's law except at very high temperatures. Whence it followed that if the determinations mere made at a sufficiently high temperature the specific heat might be sufficiently high to agree with the atomic weight 9·2.

Nilson replied to Lothar Meyer's criticism almost immediately,† in which he stated the objections which might be urged against the determination of Reynolds to which we have already referred. He also showed that every precaution had been taken in his experiments, and that no such error as Lothar Meyer imagined—an error equal to one-half the reading—was at all possible. With regard to the low value given to specific heat of oxygen in beryllium oxide by his determination (2·47), he remarked that if the molecular heat of alumina as determined by Neumann were taken (20·3), the atomic heat of the oxygen it contained became 2·83, or very little different from that found for the oxygen in beryllium oxide; and if again Regnault's number (22·3) were taken, the atomic heat of the oxygen became 3·5, or very much less than that of the other sequioxides (about (4·6). He was of opinion that beryllium showed far more analogy with the metals of the cerite and gadolinite metals than with those of the magnesium or of the aluminium series.

So remained the subject for two years; but within the last few months Nilson and Petterson have again taken it up.* They published, in the first place, the results of several careful determinations to establish the equivalent weight of beryllium more accurately. Employing the sulphate and igniting to redness, they obtained a mean value of 4·542 (O = 7·98) with a very small error between any two determinations. This slightly lowered the atomic weight, making it 13·65, though still not lower than that of carbon (12). They also made further determinations of the atomic heat of beryllium at higher temperatures, and showed that at 300° it only became 6·90, while that of iron was 7·09, the increase being at about the same rate. Further experiments on the molecular heat of the oxide and on that of alumina, scandia, and other of the rare earths, revealed the fact, that the numbers so obtained agreed very well with one another, and that the atomic heat of the oxygen contained in the first two elements was almost the same. The following is an abstract of one of their tables:—

	m.	s.	$m.s$.	A.
Be_2O_3 ..	75·32	0·2471	18·61	
Be_2	27·32	0·4246	11·60	$\frac{7·01}{3} = 2·34$
			7·01	
Al_2O_3 ..	102·8	0·1825	18·78	
Al_2	54·8	0·2143	11·74	$\frac{7·04}{3} = 2·35$
			7·04	
Sc_2O_3 ..	136·0	0·1530	20·81	
Sc_2† ..	88·0	0·1454	12·80	$\frac{8·01}{3} = 2·67$
			8·01	

They also made determinations of the molecular volume and molecular heat of the anhydrous sulphates of beryllium, aluminium, and the rarer metals of the earths, of which the following are some of their results:

	m heat.	m volume.
Beryllium sulphate	62·37	129·07
Aluminium „	63·59	126·50
Yttrium „	61·60	178·80
Erbium „	64·48	168·57
Scandium „	62 42	145·80

Showing that in all these examples the molecular heat is nearly the same, and that, for the first two, the molecular volume also corresponds with one another exceedingly well, while in the following the variation is not excessive. It was thus quite evident to the authors that the formula to be ascribed to beryllium oxide must be Be_2O_3 and not

* *Ber. Berichte*, xi., 872.
† *Ibid.*, xi., 906.

* *Ber Berichte*, xiii., 1451.
† Atomic heat of scandium was taken =6·4.

BeO. Finally, these chemists refer to a remark of Mr. T. Carnelly, who had calculated that the melting-point of beryllium chloride would lie between 547° to 600° if its formula were $BeCl_2$, and between 50° to 100° if it were Be_2Cl_6. He found the melting-point to be about that indicating the former composition, and thence went on to say, that Nilson and Pettersson's determination of the specific heat must be wrong. Nilson and Pettersson remark that the author of this astounding statement based upon such slight evidence must possess a very limited knowledge of the metals which make up Mendeleeff's third group. With the exception of aluminium, little or nothing is known of the melting- or boiling-points of the halogen compounds of the metals contained in this group, and it is obviously inconsistent to base analogies which are to extend to a whole group or series upon such insufficient data. They were convinced that enough halogen compounds would be found within this group which would not agree in their melting- and boiling-points with those of aluminium. It appeared to them strange that Carnelly should attach so little importance to their careful determinations, and should, at the same time, place such implicit confidence in the periodic law.

The *Berlin Berichte* (xiii., 1780) contains a further reply to Nilson and Pettersson's last results by Lothar Meyer. This chemist still bases his arguments upon the periodic law, and from the fact that the specific heat of beryllium rises with increase of temperature more rapidly than that of iron, silver, and platinum; he concludes that the metal belongs to the same class as boron, carbon, and silicon, as had been suggested by Brauner, although neither of these three elements were metals, and although he had previously admitted that the specific heat of the metals as a general rule is normal. But he fails to bring forward any experimental proof of his opinion to contravert that of Nilson and Pettersson.

Such, then, is the present position of this important problem. No chemist who has really made a study of the subject could accept Professor Reynolds's results as they at present stand even when supported by the periodic law. We may, therefore, lay them on one side, especially as this investigator has, as far as I am aware, not made any attempt to combat the results of the experiments of Nilson and Pettersson.* It follows that we have on the one hand, the careful determinations of these two last-named chemists on the specific heat of beryllium, and their results of the molecular heat and volume of the oxides and sulphates of beryllium, aluminium, and other metals which argue strongly for the acceptance of the atomic weight 13·65. While, on the other hand, theoretical chemists persist that Mendeleeff's periodic law has shown itself of such value in the science, and has been tested by numerous coincidences (*e.g.*, the discovery of the predicted ekaluminium-gallium, and ekuabor-scandium) that its guidance ought to be accepted absolutely. These chemists would assign the number 9·2 to the atomic weight of beryllium. If we except the fact that the specific heat of beryllium does increase with rise in temperature more rapidly than that of other corresponding metals, we have nothing to prevent our acceptance of Nilson and Pettersson's *experimental* results, based upon the well-established law of Dulong and Petit, but the *theoretical* conceptions arising from a consideration of Mendeleeff's periodic law. I should be loth to disparage the very important service which this latter law has rendered to chemical science in late years, but it must not be forgotten that we have here to deal with a fact which directly contradicts the position which it assigns to beryllium as the first member of the magnesium series; and the question arises, shall we accept the fact or the theory? I would remind my readers that if the theory is accepted and the fact rejected, they are in the position of the supporters of some of the earlier chemical theories, when once they found that a theory which had for a considerable time satisfied their wants was no longer sufficient to explain new facts, they preferred to retain the theory and to explain the facts as best they could. I am not arguing for the rejection of the periodic law, but only wish to show that if facts are discovered which are incompatible with it, it must of necessity receive some modification. Already it is insufficient to explain the physical differences between nickel and cobalt and between their compounds; and the elements with high atomic weights, including the rarer elements of which so many have been lately discovered, are simply placed in a chaotic state at the end of the table.* We cannot, therefore, reject facts for the sake of a new theory, which may be said to be but in its infancy.

It is, however, most important that the experimental results of Nilson and Pettersson should be confirmed by some independent observer—that the specific heat of beryllium should again be determined. The metal ought to be capable of preparation in a purer state than they were able to procure it, and thus one source of error would be removed. In the meantime we cannot do otherwise than accept their determination of the atomic weight (13·65), writing beryllium oxide Be_2O_3 and the other compounds with corresponding formulæ.

* A short paper was read by Professor Reynolds at the Brit. Ass., 1878, on "Double Salts of Beryllium," in which he mentioned that the metal was obtained by decomposing the double fluoride of potassium; the specific heat of the metal was 0·642.

INTRODUCTORY LECTURE
TO THE
COURSE OF METALLURGY,
AT THE
ROYAL SCHOOL OF MINES,

Session 1880-81.

By W. CHANDLER ROBERTS, F.R.S.,
Associate of the Royal School of Mines, Lecturer on Metallurgy in the Royal School of Mines, Chemist of the Mint, One of the Secretaries of the Physical Society of London.

(Concluded from p. 257).

Of all the metallurgical operations conducted in this country, those connected with iron are, of course, the most important. The production of pig-iron alone in the United Kingdom has increased from two million seven hundred thousand tons in 1852, to six million two hundred thousand tons last year, a maximum slightly in excess of this figure having been reached in the year 1872. Now the Bessemer process, the first patent in connection with which was taken out in 1855, has reduced the cost of steel from £50 to £6 per ton, and has changed the whole aspect of the iron and steel manufacture; indeed, the success with which this process alone is conducted may almost be regarded as an index of our national prosperity. Notwithstanding the almost universal depression of trade during the last few years, the outturn of steel has been steadily increasing; and it is estimated that in 1879 this country produced nearly a million tons in the Bessemer converter, double the entire produce of the remainder of the world in the year 1870 by the same process.† The outturn of Bessemer steel in America has, however, advanced with still more rapid strides; for last year she actually produced, with far fewer converters, ninety-four thousand tons more than this country. It will be evident, therefore, that every improvement effected in this process is of truly national importance, and I would briefly refer to the greatest that has been introduced in recent years.

In 1855 the fact was established that pig-iron from the blast-furnace contains the greater part of the phosphorus originally present in the ore. Dr. Percy pointed out that

* Lothar Meyer's *Moderne Chemie*—table at end.
† *The Times*, December 31, 1879.

phosphorus is not eliminated in a sensible degree in the Bessemer process, as it is in the old process of puddling; and he stated that if the Bessemer process is to be "generally applicable in this country, it must be supplemented by the discovery of a process of producing pig-iron sensibly free from sulphur and phosphorus, with the fuel and ores which are now so extensively employed in our blast-furnaces."* The problem, so far as it relates to the elimination of phosphorus, has received the attention of many of the first metallurgists in this and other countries"† but the practical application of basic linings in the Bessemer converter is the outcome of Dr. Percy's teaching; for Mr. S. G. Thomas was a student of the School of Mines, and his partner, Mr. Gilchrist, is an Associate. Mr. Snelus is also an Associate, and Mr. Riley long worked in the metallurgical laboratory. The process not only gives hope that it will be possible to utilise the large quantities of ore in the well-known Cleveland district, but is also widely practised with success on the Continent.‡ It is probable, therefore, that the large deposits of ore in the basin of the Saar, and those of Lorraine and Luxembourg, which in extent are equal to the Cleveland district, while containing a much greater amount of phosphorus, will now be available. During a recent visit to the Hoerde Works in Westphalia, where I witnessed the operation, Herr Massenez, the director, told me that 10,000 tons of "Thomas-Gilchrist" metal have already been produced there since the adoption of the process a few months ago.

The metallurgy of Copper presents several features of peculiar interest. Mr. Thomas Gibb (a student of my own year), whose work in connection with the extraction of copper by wet methods has been most important, reminds me that in 1863 the wet processes for extracting copper were insignificant; now over forty thousand tons of copper are annually produced by their aid; much has also been learnt as regards other branches of its metallurgy.

In the case of Lead, improvements have been introduced in the mode of purification that have proved to be of considerable importance. But these, as well as the modifications in the treatment of other metals, will require to be considered in some detail in the course of my lectures, and I would only now allude to the growth of the platinum industry in recent years as affording a striking instance of the application of scientific methods to metallurgy. In 1851 the amount of platinum separated from its associated metals and employed in the arts was probably not more than one-tenth of that now extracted. We owe the development of the use of this metal mainly to the eminent metallurgists, Messrs. Johnson, Matthey, and Co., a well-known member of which firm was a student in Dr. Percy's laboratory. They early adopted the classical method of Deville and Debray; and by its aid now supply about 80 per cent of the total amount of this metal annually employed in the world, in addition to other metals of the platinum group, which they alone have isolated in quantity.

I had intended to indicate the metallurgical work done by the more prominent men who have been associated with the School, but I found that it would not be possible, in the brief time at my disposal, to do justice to such as Bauerman, Dick, Hackney, Pearce, Riley, Willis, and others, whose labours have placed them so high in the ranks of English metallurgists. You will, however, as the Course proceeds, have opportunity of becoming familiar with their names.

In referring to the past teaching of the school, I must remind you of the importance of rigorous and minute inorganic analysis; and it is the more necessary that I should do so from the fact that the peculiar charm of organic research appears, as has been already pointed out by Prof. Abel,* to lead the younger chemists, to "underestimate the value and importance, in reference to the advancement of science, of the labours of the plodding investigator of analysis." I am satisfied, however, that, if we bear the traditions of the Chemical and Metallurgical laboratories of the School of Mines in view, we are not likely to underrate the importance of analytical work; and much conclusive evidence as to the value of the teaching of the past thirty years is afforded by the labours of the accomplished analysts who have, from time to time, worked under Dr. Percy's direction.

The direct influence of the School on the success with which metallurgy has been practised in this country has been most marked, and would alone afford an answer to the question whether the possession of high scientific attainments is generally advantageous to the successful conduct of metallurgical works. It must not be forgotten that our subject is constantly receiving valuable aid from branches of science other than chemistry; and this can hardly be better shown than by the growing importance of physical research in connection with metallurgical problems. I would incidentally remind you that it is the more important for us to consider this, because special attention was directed to the question in the evidence given before the Royal Commission on Scientific Instruction,† whose recommendations will, it is to be hoped, extend the influence of the School of Mines.

In connection with this branch of our subject a most prominent position must be given to the production of high temperatures, as it will be obvious that we have principally to consider the reactions of the elements when under the influence of heat. In the first half of the present century temperatures higher than the melting-point of zinc were not known with any degree of certainty; but in 1856‡ M. Henri St.-Claire Deville pointed out that chemistry at high temperatures, that is to say, up to the blue-white heat at which platinum volatilises and silica fuses, remained to be studied. Since then, in conjunction with M. Troost, he has given us certain fixed points, such, for instance, as the boiling-points of cadmium and zinc; and Deville's researches on dissociation have entirely modified the views generally entertained in regard to the theory of combustion. Indeed, we owe so much to this illustrious teacher, that the best homage we can offer him will be to work in the directions he has indicated. M. Stas has proved that it is perfectly easy to distil even large quantities of silver from one lime crucible to another,§ a fact which has been taken advantage of by Mr. Lockyer and myself in some experiments on the absorption-spectra of the vapours of certain metals at high temperatures.‖

As regards scientific advance of a more essentially practical character, the gradual discovery of the fact that in certain cases fuel can be best employed if it be previously converted into gas, and the recognition of the advantages to be derived from a preliminary heating of the gases and the air, has led to the wide adoption of the regenerative system, by which the waste heat of the furnace is utilised for heating the incoming air or combustible mixture of air and gas necessary to effect the required operation. Dr. Siemens has thus shown us how to economise fuel to a vast extent, it being now possible to produce a ton of steel by the use of 12 cwts. of small coal, instead of 3 tons of coke required to melt it in the old form of furnace. By the command of high temperatures, moreover, he has developed new processes in the metallurgy of iron, which are resulting in the replacement of the old "cinder-mixed" wrought-iron by "cinder-free" ingot iron and steel.¶ The degree of heat attainable by the regenerative furnace

* "Metallurgy"—Iron and Steel (1864), p. 819.
† M. Gruner, *Annales des Mines* (1869), t. xvi., p. 199.
‡ M. Gruner, *Annales des Mines*, part 1 (1879), p. 146. H. von Tunner, *Zeitschrift der berg- und hüttenmännischen Vereins für Steyermark u. Kärnten*, xii. Jahrg., Mai-Juni, 1880. Herr J. Massenez, *Engineering*, vol. xxx. (1880), p. 198.

* "British Association Report, Plymouth" (1877), p. 44.
† Report, vol. ii., "Minutes of Evidence," p. 86 (1874).
‡ *Ann. Chim. et Phys.* [3], t. xlvi, p. 182; *Comptes Rendus*, t. xc. (1880), p. 773.
§ "Sur les Lois des Proportions Chimiques" (1865), p. 37.
‖ *Proc. Roy. Soc.*, vol. xxiii. (1875), p. 344.
¶ Akerman, *Journal of the Iron and Steel Institute*, No. 2 (1878), p. 360.

is, however, limited to the temperature of dissociation of carbonic acid and aqueous vapour, so that the temperature never exceeds about 2600° C.; but during the present year* Dr. Siemens has employed the far greater heat of the electric arc for the fusion of steel and platinum.† Bearing in mind the interest excited by recent experiments on the effect of intense heat on bodies now considered to be elementary, we may expect physicists to look to us for aid in developing the methods of employing high temperatures.

We shall have to consider very carefully the physical work which groups around the metallic alloys. It has long been known that the union of two or more metals produces a result which often differs more in physical properties from either of its constituents than they do from each other. There is strong evidence that metals combine in chemical proportions; and we may turn with advantage to the class of alloys, certain of which have been in use from prehistoric times—the alloys of copper and tin. Here are two copper-tin alloys, one containing 61·7 per cent of copper, and the other 68·2 per cent. They correspond respectively to the formulæ $SnCu_3$ and $SnCu_4$; they only differ by 6·5 per cent, and yet their physical properties are in certain important respects totally distinct. This essential difference in their properties produced by a small difference of composition brings me to one very distinctive feature of metallurgy, the enormous influence exerted on a large mass of metal by a trace of another metal or metalloid—that is, by a quantity so small that it appears to be out of all proportion to the mass in which it is distributed.

I think it may safely be asserted, that in no other branch of applied science has the operator to deal with quantities that are at once so vast and so minute; and the Course will not have proceeded far before you will recognise this fact.

It may be that the trace to be extracted is alone of value—as, for instance, the few grains of gold that can be profitably extracted from each ton of a material, which, though containing only one part of gold in five millions by volume, is thereby entitled to be regarded as an auriferous deposit that can be profitably worked; or it may be the minute percentage of a metalloid which must be extracted, in order that the physical properties of a large mass of metal may not be entirely altered.

Let me give you a few instances of the influence of small traces of metal.

The presence of only 1-300th per cent of antimony in a mass of molten lead, the surface of which is exposed to the air, will cause it to be rapidly oxidised, while a similar mass of lead of equal surface, but free from the minute quantity of antimony, will be but slowly acted upon; and it has been shown by the late Mr. Baker, of Sheffield, a distinguished student of the School, that 7-1000ths per cent of copper is detrimental to the lead employed in the manufacture of white lead.

The presence of 1-20th per cent of lead or certain other metals in standard gold will render a bar an inch thick so brittle that it may readily be broken by a slight rap with a hammer. Less than ½ per cent of iron in metallic copper will reduce the electrical conductivity by about 60 per cent, while a far smaller quantity will render it quite unfit for manufacture into telegraph cables, or for other electrical purposes.

In 1866, Graham showed,‡ by experiments with which I had the privilege of being connected, that the presence of occluded gases in metals often exerts a marked influence on their molecular structure. In the case of iron he urged that metallurgists should study the effects of occluded gases, more especially carbonic oxide, the weight of which, according to his experiments, could not exceed the 1-15 per cent of the weight of iron in which it was present. The significance of such facts is now under consideration by a Committee of the Institution of Mechanical Engineers;* and the question of the presence of gas in steel, either occluded or retained in the form of bubbles, is further being investigated by Chernoff,† Müller,‡ and others.

There are many cases in which the malleability of metals is seriously compromised by the presence of oxygen, either dissolved or in a combined form. The addition, however, of a minute quantity of a metal or metalloid capable of combining with the oxygen without itself exerting an injurious influence on the metal produces a most marked beneficial effect. Thus, if 7-100ths per cent of phosphorus in the form of phosphide of copper be added during the operation of "poling" copper, its action is stated to be most serviceable, although only 3-100ths per cent is actually retained by the metal.§

It is, however, in the metallurgy of Iron and Steel that the influence of minute traces of impurity is most marked; and on this subject it will be necessary to enter into considerable detail during the course of lectures, but I must now confine myself to a few instances only. I have already referred to the importance of the elimination of phosphorus in the manufacture of malleable iron and steel. It is known that a minute quantity of this elementary body may be highly injurious to the metal, even if the relation between the carbon and manganese is favourable. I would refer, for instance, to the tests made on certain plates of Swedish puddled iron exhibited in the Paris Exhibition of 1878, which were found to have a far higher resistance to fracture by impact than certain other plates compared with them; and yet analysis proved that the main difference between them lay in the fact that the good plates contained only 2-100ths per cent of phosphorus, whereas the inferior plates contained 1-10th per cent more.‖

Carbon, it is well known, gives to iron fusibility, and renders it capable of being cast in moulds. The results of very many experiments appear to show that the presence of 15-100ths per cent of carbon converts iron into steel, rendering it capable of being slightly hardened; beyond 1¼ per cent of carbon the metal ceases to be malleable, and it is known as cast-iron.

The influence of carbon on the tensile strength of steel is very remarkable. Mr. Willis, the able chemist of the Landore Siemens Steel Works, tells me that two samples under identically favourable conditions as to their content of sulphur and phosphorus, but containing 15-100ths and 18-100 per cent of carbon respectively, will differ by 6 tons per square inch in breaking-strain, or by an increase in the latter case of 27 per cent. But carbon is far from being the only metalloid that exerts a marked influence on the physical properties of iron. Manganese, for instance, is generally considered to act in a manner similar to carbon; and Willis has shown¶ that an ingot of a certain variety of steel containing no manganese will break into pieces at the first blow of the hammer, whereas a similar ingot containing 8-100ths per cent of that metal will forge readily. The influence of phosphorus has already been referred to; and during the Course we shall consider together the manner in which the character of iron and steel is modified by the presence of minute quantities of sulphur, silicon, and other metalloids, as well as of a few metals. The problems to which they individually give rise are very complicated; but when several are present

* *Engineering*, vol. xxix. (1880), p. 478.

† Figures convey but little impression as to such high temperatures; but it may be mentioned that Dewar has given 7000° C. as approximately the temperature of the electric arc ("British Assoc. Report," 1873, p. 466), and, according to Rosetti, the true temperature of the sun can hardly be less than 10,000° C., or more than 20,000° C. *Phil. Mag.* [5], vol. viii., p. 550 (1879).

‡ *Phil. Trans.*, 1866, p. 438.

* "First Report of the Committee on the Hardening, Tempering, and Annealing of Steel," 1879.

† "On the Structure of Cast-Steel Ingots," Translated for the Institution of Mechanical Engineers by W. Anderson, C.E. (1879).

‡ *Berichte der Deutschen Chemischen Gesellschaft*, 1879, No. xii., 93. *Glaser's Annalen für Gewerbe und Bauwesen*, August, 1880, p. 138.

§ W. Weston, *Phil. Mag.* [4], l., p. 542.

‖ Akerman, *Journal of the Iron and Steel Institute*, 1878, No. 2, p. 363.

¶ *Journal of the Iron and Steel Institute*, No. 1 (1880), p. 92.

together the question becomes so involved that it will be long before we can hope for a complete solution.

Dr. Fleitmann, of Iserlohn, has recently shown* that nickel, which breaks under the rolls, may be made perfectly malleable by the addition of a little over 1-10th per cent of magnesium, and at the Düsseldorf Exhibition I saw thin sheets of large dimensions produced by his method. M. J. Garnier has also shown† that malleability may be ensured by adding 3-10ths per cent of phosphorus.

A fact of much interest in relation to the assay of gold has been discovered by Dr. A. D. van Riemsdijk, of Utrecht,‡ who has shown that the presence of 1-100th per cent of certain metals of the platinum group may be detected by the fact that the cooling mass of molten metal does not "flash" or pass through the remarkable state known as "superfusion."

I must not further multiply instances, but will only mention that M. Nyst, of the Brussels Mint, has lately found that the presence of 15-100 per cent of silicon in standard gold will so affect its molecular grouping as to render it possible for a thin strip to bend by its own weight, as zinc would, in the flame of a candle.

The growing importance of physical research in connection with metallurgy is shown by the fact that physical methods are now constantly appealed to by those interested in metallurgy, more especially in the case of iron and steel. We are told, for instance, that the hardness of steel may be correctly inferred from a numerical determination of its coercive force;§ it is sought to establish the actual nature of the change in the mode of existence of the carbon in steel that accompanies hardening by determining its thermo-electric properties;‖ and the hope is held out¶ to us that the time will soon come when boiler makers will electrically test their plates, possibly by the aid of the induction-balance, just as they now test them for ductility and tenacity. I can only add the expression of a belief that this powerful weapon of molecular research which Prof. Hughes has given us will yield good results in the hands of some of you.

The varied materials now used in the Bessemer and Siemens-Martin processes have greatly complicated what is known as ingot metal; and the enormous increase in recent years in the use of certain varieties of steel has rendered it necessary to scrutinise more rigorously the analytical and other methods of estimating the amount of such elements as manganese, chromium, and silicon, the presence of which we have seen produces such remarkable effects. Many skilful observers have, therefore, as might have been expected, sought the aid of the spectroscope.

Its use for determining the point at which decarburisation has ceased in the Bessemer converter was pointed out by Dr. Roscoe,** followed by Lielegg, Wedding, and Marshall Watts;†† and more recently Messrs. Parry and Tucker,‡‡ of the Ebbw Vale Works, have shown that the influence of mere traces of certain impurities on the working of iron renders it very desirable to add spectroscopic observations to the ordinary chemical analysis. In 1874 Mr. Lockyer and myself made experiments on the quantitative analysis of certain alloys by means of the spectroscope;§§ and in the following year Sir John Alleyne‖‖ described a method for estimating small quantities of phosphorus in iron and steel by its aid, which possesses much interest.

The result of mechanical tests are even more important. Not long since the appearance of the fracture of a sample of metal was considered to afford trustworthy and sufficient evidence as to its nature and properties; but such rough methods have given place, in the hands of Kirkaldy and others, to the rigorous physical and mechanical investigation to which metals must now be submitted as a matter of ordinary routine. The results, tabulated or plotted into curves, which mark the influence of each constituent or impurity, form permanent records of the greatest value.*

The most careful mechanical and physical tests do not, however, necessarily supply all the information required. The complex varieties of iron and steel now used seem, as M. Lan has pointed out,† to be specially liable to what may almost be called a molecular mobility, in virtue of which, when subjected to shocks or vibrations of sufficient intensity, a structural re-arrangement is set up; of their behaviour under these circumstances the previous static tests by traction can give no indication.

It has only been possible for me to indicate the more important conditions affecting the successful practice of Metallurgy. I have traced the relation between technical and scientific workers; but there is yet another condition of somewhat recent growth. The enormous scale on which operations are now conducted renders it more necessary than formerly for those engaged in metallurgical enterprise to seek the aid of capitalists. The result is that a large share in the control of many important works falls to the non-scientific members of the Board of Directors, men of high commercial ability, but whose knowledge of the importance of scientific work is necessarily limited. It is true that they may recognise the necessity for scientific aid in the works with which they are connected, but they are too often unconscious of the labour and difficulty that are involved in the attainment of accurate scientific knowledge. I am convinced, however, that facts are gradually compelling them to recognise that the value of a metal may entirely depend on whether it does or does not contain a trace of impurity, and that the exact method of treatment to be adopted depends much on the character of the materials employed; they will therefore examine more carefully than they have hitherto done the qualifications of men to whom important duties are entrusted, and will insist that the services of only adequately trained metallurgists shall be secured.

I shall have to direct your attention to the minute care with which details affecting commercial interests are now investigated;‡ and your success will further depend on the facility with which you are able to use the "tools of thought" furnished by chemistry, physics, and mechanics. Whether you will ever possess the tact and judgment necessary to direct such works as Dowlais with an army of ten thousand people, obviously depends on personal qualifications which I can but little influence.

I venture to hope that you will, by original research, add to the general advance of science, for, as the late Prof. Clifford has reminded us, what has often proved to be the most useful parts of science have been investigated for the sake of truth and not for their usefulness.

Dr. Percy found Metallurgy practised in this country mainly as an empirical art. He may well feel, to borrow the words of an old writer, that in his hands "the business of Metallurgy and Essaying has not only been illustrated but also improv'd, amended and enrich'd;" for his works contain a record of its progress, his teaching and researches have secured it a scientific basis, and he has trained a body of scientific workers, in whose hands the immediate future of metallurgy to a great extent rests.

---

* *Deut. Chem. Gesel.* (1879), vol. xii., p. 454. English Patent Specification, No. 5126 (1878).

† *Comptes Rendus*, xci. (1880), p. 331.

‡ CHEMICAL NEWS, vol. xli. (1880), p. 126; *Ann. Chem. et Phys.* [5], tome xx., p. 66.

§ Tréve and Durassier, *Comp. Rend.*, t. lxxx. (1875), p. 799. Wattenhofen, *Journal of the Iron and Steel Institute*, 1879, No. 1, p. 305.

‖ Barus, *Phil. Mag.* [5], vol. viii., p. 341.

¶ W. H. Johnson, CHEMICAL NEWS, vol. xlii. (1880), p. 70.

** *Proc. Lit. and Phil. Soc. Manchester*, 1863, iii., p. 57.

†† *Phil. Mag.* (4), xxxiv., p. 437.

‡‡ *Journal of the Iron and Steel Institute*, 1880, No. 1, p. 163.

§§ *Phil. Trans.*, clxiv. (1874), p. 495.

‖‖ *Journal of the Iron and Steel Institute*, 1875, No. 1, p. 62.

* V. Deshayes, "Classement et Emploi des Aciers" (Paris, 1880); also *Bull. Chem. Soc.*, tome xxxi. (1879), p. 166. H. Lebasteur, "Les Métaux á l'Exposition de 1878" (Paris, 1878).

† M. Lan, 'La Métallurgie á l'Exposition de 1878" (Paris, 1879); also *Ann. des Mines*, Mai-Juin, 1879.

‡ In illustration of this see an exhaustive mathematical paper on the values of iron ores by Prof. A. Habets: Cuyper's *Revue Universelle des Mines*, tome i. (1877), p. 504.

Bearing in mind how much the progress of our science means to England, I cannot but be conscious that, in attempting to continue this work, I undertake a grave responsibility.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, November 18, 1880.

Prof. H. E. Roscoe, President, in the Chair.

It was announced that a ballot for the election of Fellows would take place at the next meeting, December 2.

The following certificates were read for the first time :—S. Harvey, J. W. James, W. E. Kay.

Mr. Spencer Pickering then communicated a lengthy paper entitled "*Notes on the Oxides of Manganese.*" Various samples of oxides of manganese were obtained, and heated to various temperatures until their weight was constant. The results obtained showed that these oxides sometimes lost and sometimes gained in weight; at other times their weight remained constant. This loss and gain of oxygen does not appear to bear any relation to the degree of oxidation of the oxide. It appears to be greatly dependent on the amount of water present in the sample. The greatest loss is found to occur in those oxides which were examined soon after they were prepared. The oxides of manganese appear to undergo a molecular change on being kept in air for any length of time, whereby their behaviour on heating may be entirely reversed, a gain of oxygen taking place instead of a loss. This molecular change is not accompanied by a variation in composition. When small quantities of manganese oxides are heated in a platinum dish over a Bunsen burner, the oxide obtained was remarkably constant in composition when the gas was at the day pressure: with a larger supply of gas less constant results were obtained.

The President said that the oxides of manganese seemed sometimes to lose and sometimes to gain in weight when heated to 100°. The circumstances which governed this alteration he hoped the author would eventually succeed in determining. He should like to ask if any special tests had been made for the presence of organic matter, and whether any specific gravities of the oxides had been taken.

Dr. Wright asked if the absence of other metallic oxides had been secured, as in his researches great care was found to be necessary in this respect.

Mr. Pickering replied that the pure oxides used in his research, after solution in acid and precipitation with ammonium sulphide, gave no fixed residue on evaporation with sulphuric acid. Some of the specimens were very light and some very heavy powders. The presence of organic matter could not account for a gain in weight.

Prof. McLeod said that it would be interesting to know if any oxygen was given off at ordinary temperatures in a Sprengel vacuum.

The President then called upon Dr. Gladstone to read a paper by himself and Mr. A. Tribe, entitled "*Aluminium Alcohols (Part I., Their Preparation by Means of the Aluminium-Iodine Reaction).*" In 1876 the authors showed that either aluminium or aluminium iodide singly is without action on absolute alcohol, but that together they decompose that liquid with facility. The resulting bodies are hydrogen and two new organic aluminic compounds, aluminic iodo-ethylate $(C_2H_5O)_3I_3Al_2$, and aluminic ethylate, $Al_2(C_2H_5O)_6$. It was also shown that one molecule of the iodide suffices to bring about the combination of very many atoms of aluminium with the oxy-radical of the alcohol, and that the amount of hydrogen set free is equivalent to that of the metal which disappears. In the present communication the authors have studied more completely the composition and properties of the ethylate, and have applied the aluminium-iodine reaction to the preparation of analogous aluminium derivatives of other alcohols. 20 c.c. of alcohol, 2 grms. of aluminium-foil, and 1 grm. of iodine are heated in a flask to 100°: the decomposition proceeds with tolerable rapidity until the metal has disappeared. The flask is then heated to 300° until distillation at that temperature ends. It is then connected with a receiver, and the apparatus exhausted of air, the product in the flask melted and distilled under diminished pressure. The authors have prepared and examined aluminic methylate, aluminic ethylate, aluminic propylate. No reaction took place when iso-propyl alcohol was used, although the iso-iodide and the zinc iso-propide are less stable than the corresponding normal compounds. Aluminic isobutylate and aluminic amylate were prepared without difficulty. Aluminic acetylate was formed, but was to a great extent decomposed by the temperature necessary for its formation by this reaction. On trying the reaction with allyl alcohol aluminic allylate was apparently formed, but could not be isolated by distillation *in vacuo*. Aluminic phenylate, cresylate, and thymolate were prepared, but could not be distilled; they were, however, obtained tolerably pure by heating the respective alcohols to about 200° with the theoretical quantity of aluminium and enough iodine to start the action, and then pouring off the semi-fluid product. The hydrogen of benzylic alcohol can be replaced by aluminium, but the compound formed is completely decomposed when heated *in vacuo*. No aluminium compounds of ethene alcohol or propenyl alcohol were obtained. The aluminic alcohols are solid, non-crystalline, greyish white bodies, and are more or less decomposed on heating at the ordinary atmospheric pressure, but those of the methyl series distil at reduced pressure, and have the property of remaining fluid below their fusing-points.

In reply to Dr. Armstrong, Dr. Gladstone said that an attempt had been made to determine the vapour-densities of these bodies, but up to the present time had not been successful.

Mr. W. H. Perkin then gave an account of the artificial production of indigo, and prepared some before the Society. He stated that through the kindness of Dr. Caro he was enabled to exhibit some specimens of artificial indigo, and to demonstrate its preparation. We are indebted to Prof. Adolph Baeyer for the discovery of the process. The starting-point is practically toluene, C_7H_6O; indigo, therefore, may be classed among the coal-tar colours. From this hydrocarbon cinnamic acid is prepared by a process which was suggested by Mr. Perkin not long ago, and which at the time did not seem likely to be so soon turned to a practical application. The next step is the conversion of the cinnamic acid into its nitro-derivative by the action of nitric acid. Two isomers can be thus formed, the ortho and the para: the ortho is the only one which is useful in this process. Fortunately, by employing certain precautions, this ortho body can be obtained as the chief product of the reaction. On exposing this nitro body to the vapour of bromine ortho-nitro-dibrom-hydro-cinnamic acid is prepared. By treatment with caustic soda ortho-nitro-propiolic acid is obtained, which, on reduction by grape-sugar in a solution rendered alkaline by an alkali or an alkaline earth, is converted into indigo. The steps in the process are therefore:—Toluene, C_7H_6O; dichloride of benzyl, $C_6H_5,CHCl_2$: cinnamic acid, $C_9H_8O_2$; ortho-nitro-cinnamic acid, $C_9H_7(NO_2)O_2$; ortho-nitro-dibrom-hydro-cinnamic acid, $C_9H_7Br_2O_2(NO_2)$; ortho-nitro-phenyl-propiolic acid, $C_9H_5(NO_2)O_2$; and finally, indigo, $C_{16}H_{10}N_2O_2$. Prof. Baeyer has also discovered a second process by heating ortho-nitro-phenyl-oxacrylic acid to about 110°, but practically this process is not so good as the one just mentioned. The artificial indigo is identical with the natural product in every respect: it can be reduced to form an indigo-vat, and gives a sulpho-acid soluble in water, which dyes silk. The colouring matter may be

made in the fibres of the fabric by passing them through, or printing them with a mixture, $C_6H_5(NO_2)O_2$, alkali, and grape-sugar, and then steaming or heating them for a few minutes. Every effort is being made on the Continent to produce the colouring matter commercially, and there is but little doubt as to the ultimate and speedy success of these endeavours.

The President, in thanking Mr. Perkin for his interesting demonstration, commented on the very superior facilities which existed in Germany in the technical institutions and the large manufactories for working out such questions as the above. In one large works no less than thirty chemists were employed, at liberal salaries, working at subjects connected with chemical technology. If such arrangements existed in this country we should have nothing to fear from competition.

"*On the Absorption-spectrum of Ozone*," by W. N. Hartley. The author has photographed, by means of the light afforded by the coil and Leyden jar (which also served to ozonised the air), the absorption-spectrum. The absorption-band stretches from wave-length 285 to 233 millionths of m.m.: the air contained 1 vol. of ozone in 2000 of oxygen. Great care was taken to exclude chlorine and oxides of nitrogen. The mean wave-length of the rays intercepted by ozone is 256 millionths m.m. From this the author deduces the mean rate of vibration of the molecule of ozone as 1231 billions per second.

"*On the Probable Absorption of the Solar Ray by Atmospheric Ozone*," by W. N. Hartley. The author refers to the recent experiments of Cornu on the shortening of the solar spectrum in the ultra-violet portion. This observer has photographed the spectrum at different altitudes. He finds that the longest spectrum was obtained at the greatest height at mid-day; the shortening is therefore due to the atmosphere. From various considerations the author concludes that it is highly probable that the absorbing substance in the atmosphere is the ozone. The author attributes the blue tint of the atmosphere to a great extent to ozone. The blue colour cannot be due to the aqueous vapour nor the oxides of nitrogen. Some further experiments on this interesting question are promised.

"*On the Synthetical Production of New Acids of the Pyruvic Series* (*Part II., Isobutyryl and Butyryl-formic Acids*)," by E. Moritz. The author has prepared and studied the following bodies:—Isobutyryl-formic amide, di-isobutyryl-dicyanide, and isobutyryl-formic acid. The acid was prepared by treating the polymeric cyanide with hydrochloric acid, and subsequent boiling in a water-bath. If the mixture of cyanide and hydrochloric acid be poured into cold water before boiling oily drops form at the bottom, which subsequently solidify. Two substances were isolated from this deposit, one soluble in sodic carbonate fusing at 187°, the other insoluble, fusing at 207° to 208°. The author has also prepared and studied butyryl-formic amide, dibutyryl-dicyanide, and butyryl-formic acid. In conclusion, the author states that an improved method for preparing the acid-radicle cyanide is necessary for the success of further investigations.

"*On the Ancient Alum Well at Harrogate*," by R. H. Davis. This old well was noticed by Dr. Garnett in 1791 as containing alum and iron. Up till 1870 the well seems to have been forgotten; in that year, however, it was brought to light again during some excavations made for increasing the supply of sulphur-water. It is a pale reddish brown water, strongly acid to litmus, and very astringent to the taste. The well is surrounded with sulphur-wells, and is of comparatively superficial origin. The author gives an analysis of the water in grains per gallon:—$Fe_2(SO_4)_3$, 78·76; $FeSO_4$, 69·33; $Al_2(SO_4)_3$, 89·47; $CaSO_4$, 56·91; $MgSO_4$, 57·38; K_2SO_4, 3·14; Am_2SO_4, 2·19; NaCl, 33·9; and SiO_2, 3·27. Total residue, 397·25.

"*On Peppermint Camphor*," by M. Moriya, of Tokio. This paper forms No. IV. of the contributions from the University Laboratory of Tokio, and forms part of a thesis presented by the author on graduating in chemistry. In 1862 Oppenheim concluded that this camphor was a mono-atomic alcohol,—

$$\left.\begin{matrix} C_{10}H_{19} \\ H \end{matrix}\right\} O,$$

and named it Menthol. In 1876 Beckett and Wright showed that menthol was connected with the aromatic and paraffin series. The sample examined by the author was obtained from Yonezawa. Its specific rotatory power was $-59·3°$; sp. gr. at 15°, 0·89; melting-point, 37° to 35°: distils over at 210° to 212°; crystallised in long needles; soluble in absolute alcohol, ether, CS_2, chloroform, and glacial acetic acid. By the action of bichromate and sulphuric acid at 120° for ten hours a colourless oil was obtained, $C_{10}H_{18}O$, boiling at 204° to 205°; sp. gr. 0·9032; insoluble in water; soluble in ether, alcohol, and chloroform. By the action of nitric acid an explosive nitro-body, probably $C_{10}H_{19}NO_2$, was obtained, yielding an amide, $C_{10}H_{19}NH_2$. By treating the camphor with twenty times its volume of fuming nitric acid a yellow liquid is obtained, which on evaporation yielded a white crystalline substance, soluble in water, which contained no nitrogen. Analysis indicated the compound to be normal pyro-tartaric acid. Bromo-menthol, $C_{10}H_{19}Br$, was also prepared. By the action of zinc chloride menthene was obtained. By freezing the oil of peppermint obtained by distilling the plant and separating the crystals, and subsequently fractionally distilling, a liquid was obtained, which the author concludes to be the liquid which holds the camphor in solution. It has the composition $C_{10}H_{18}O$. In a note to the paper Prof. Atkinson suggests constitutional formulæ for menthol founded on the above researches.

The Society then adjourned to December 2, when a ballot will be held for the election of Fellows, and the following papers will be read:—"Communications from the Laboratory of the University College, Bristol," by W. Ramsay; "On the Specific Volume of Chloral, by Laura Maude Passavant, Brown Scholar at the Yorkshire College; "On the Formation of Carbon Tetra-bromide in the Manufacture of Bromine," by J. W. Hamilton.

PHYSICAL SOCIETY.

Saturday, November 13, 1880.

Prof. W. G. Adams in the Chair.

Mr. Bosanquet, of St. John's College Physical Laboratory, Cambridge, read a paper "*On the Nature of the Sounds which occur in the Beats of Consonance*." From mis-timed octaves and twelfths he found that when the beats of the harmonics are cleared away each beat consists entirely of variations in the intensity of the lower notes. He gave the mathematical theory of these beats, and likewise of the curves given by the harmonograph. He also described an ear-tube for using in connection with a resonator. It is difficult to get definite results with a resonator unless the passage from the latter to the ear is closed to sound. The ear-tube consists of a copper pipe bent into a sickle shape to gird the face so that the ends may enter the ears into which they are screwed, plugging them close. The sound is led from the resonator to the middle of this bent pipe by a flexible india-rubber tube, and thence to the ears.

Mr. Brown read a paper "*On Action at a Distance*." He drew attention to the fact that though Newton disbelieved in action at a distance, he did not pronounce whether the medium was material or immaterial. Mr. Brown showed that the hypothesis of a material medium was encumbered with difficulties, since, among other reasons, direct contact could not explain gravity, projection of small particles from one body to another could not explain attraction, and Le Sage's theory of corpuscles (as modified by Mr. Tolver Preston) required an enormous degree of porosity in masses of matter. The nature of magnetism and vibrations was also discussed by the author.

Mr. J. Macfarlane Gray read a paper "*On the Mechanical Nature of the Forces called Attraction*," and gave grounds for attributing them to the pressures of a universal material ether of a gaseous nature. The paper was long, and had to be in part left unread. The hypothesis held by Mr. Gray is remarkably confirmed by numerical results obtained by him.

Professor Cottrell threw some doubts on Mr. Gray's results, on the score that numerical coincidences were not always safe ground for basing theoretical deductions on.

Mr. Gray stated that in the parts of the paper which had to be skipped, Prof. Cottrell's objections were answered. He also pointed out that Mr. Brown in his criticism of the gasiform ether had not taken into account the important condition that the particles of ether have volume.

Professors Perry and Ayrton read a "*Note on the Contact Theory of Herr Exner*," recently brought before the Academy of Sciences, Vienna. They showed that Exner's experimental results disagreed with the concordant results of several independent experimenters, namely, Kohlrausch, Hankner, and Ayrton and Perry. They concluded that Herr Exner's experiments were inaccurate. They further argued that Exner's second and later paper, so far from being a disproof of the contact theory of electromotive force as now received, is in reality a proof of it.

Dr. Wright stated that he will read a paper on this subject soon; and Prof. Reinhold said that Herr Exner had since corrected some of the results of his earlier papers on contact electricity.

Prof. Minchin, of Cooper's Hill Engineering College, exhibited a New Photo-electric Cell. This consists of a vessel of water containing a little acid carbonate of calcium, and two tinfoil plates. When a beam of lime-light was allowed to fall on one of the plates a powerful current was set up in the cell, as seen by the deflection of a galvanometer connected in circuit with the plates. When a red glass screen intercepted the beam the effect was very slight. Prof. Minchin had begun his experiments with fluorescene, but found "hard" water, containing this salt of lime, do equally well. The cell possesses this advantage—that the current it gives soon decreases in the light. When first the light falls on it the exposed plate is positive, but it soon changes to negative. Prof. Minchin had tried the cell in place of a selenium one in the photophone, but with unsatisfactory results.

CORRESPONDENCE.

THE SPECIFIC ROTATORY POWER OF CANE- AND INVERT-SUGAR.

To the Editor of the Chemical News.

Sir,—In his last letter (page 221) Mr. Watt demurs to my statement of the nature of his doubts, and defines them for himself. With regard to your correspondent's first point, in which he questions "that any authority should fail to take into account the increase of weight by inversion," I can only refer him again to the two notable instances adduced in my former letter. Whether Mr. Watt "accepts" them or not, there can be no doubt that they are distinct cases in which it has been assumed that a solution of invert-sugar contained the same percentage as before inversion. They are not the only published cases of the sort, and the private correspondence which has arisen from my paper shows that the same omission has been pretty widely practised.

I certainly thought that I had sufficiently explained that I was not prepared to adhere to my suggestion—for it was nothing more—that the value $-25°$ was erroneous *because* the increase of weight by inversion was ignored. Anyhow, I now state definitely that I think Mr. Watt has shown that such was not the origin of the erroneous value. But the erroneous calculations remain as facts, whatever their origin, and clearly prove my statement that the increase of weight is not always taken into account.

I may point out that the value Sj or $[\alpha]j = -26°$ at 14, for invert-sugar, was based on the facts that a solution of cane-sugar which rotates $+100$ divisions before inversion will read -37 divisions at 14° C. after inversion; and that the specific rotatory power of cane-sugar is 73·8° for the transition tint. I by no means contend for the accuracy of these data, but I protest against chemists playing fast and loose. They must not with the same breath accept the above data as facts and yet give $-25°$ as the value of Sj for invert-sugar at 14° C.

But there is another view of the subject to which my attention has been further called since the commencement of this correspondence, by a valuable private communication from Mr. A. Watt. In my paper, the conclusions were deduced from published observations made with instruments employing the transition-tint. It is unfortunate that whilst Soleil's instrument is rapidly becoming superseded by polarimeters employing sodium light, very few observations have been published of the rotatory power of *invert*-sugar, as determined by the latter instrument. Again, in English works, the polarimeters employing sodium light have hitherto received very meagre attention, and in some of the most recent English researches on sugars, as those of O'Sullivan and Brown and Heron, the rotatory powers are all determined by instruments using the transition-tint. But the transition tint is not a ray of definite refrangibility, and is even said to vary with the idiosyncracy of the observer. Further than this, it is well known that the relation of Sj to S_D is not the same for tartaric acid as it is for quartz, and although saccharine solutions are stated to follow the same law as the latter, it is by no means certain that this is true for all descriptions of sugar. On all these accounts it is preferable to make observations of specific rotation by sodium light, and in recording them the strength of the solution employed should always be stated. The importance of this factor is well shown in the following determinations by Hesse,* employing solutions of cane-sugar of various concentrations:—

Grms. of Sucrose per 100 c.c.	Value of S_D.
1	67·95
2	67·39
3	67·05
6	66·67
10	66·50
20	66·45

These results are in each case the mean of several independent determinations. Beyond a concentration of 10 *c* (*c* = grammes per 100 c.c.) the decrease is pretty regularly 0·005° for each 1 *c*. The value of Hesse for the specific rotation of cane-sugar agrees with that of Tuschmidt,† who obtained 66·42 (apparently for somewhat concentrated solutions), and Backhoven,‡ who obtained the same number. Schmitz, again, has found 66·42 and 66·53 as the value of S_D when $c = 10$;§ and, lastly, Tollens gives $+66·48°$ as the correct value for S_{10D} in the case of cane-sugar.‖ These closely corresponding results afford overwhelming evidence in favour of a number closely approximating to $+66·5°$ for cane-sugar in solutions containing from 10 to 20 grms. per 100 c.c. It must be remembered, of course, that this is the *apparent* specific rotation for the concentration in question, the *absolute* value of S_D for cane-sugar being according to Tollens $+63·90°$, and according to Schmitz $+64·16°$.

Some of the values for the ratio $S_D : Sj$ were given in my paper. Although those given appear to agree fairly well among themselves, the discrepancy between them becomes more apparent if they be used for calculating a constant

* *Annales de Chemie*, clxxvi., 95.
† *Journ. f. Prakt. Chem.*, [2], ii., 235.
‡ *Ibid.*, page 277.
§ *Ber. der Deutsch. Chem. Gesell.* 1877, p. 1414.
‖ *Ibid.*, p. 1403.

number for S_D into its equivalent in Sj. Thus if 66·5 be accepted as the value of S_D for cane-sugar, then the following numbers will be obtained on using the factors of various authorities for Sj:—

S_D. ×	Factor.	=	Sj.	Authority.
66·50 ×	1·129	=	75·08	Landolt.
	$\frac{24}{21·67}$	=	73·65	Broch.
	$\frac{24}{21·8}$	=	73·21	Girard and De Luynes.
	$\frac{24}{21·54}$	=	74·09	Brown and Heron.
	1·091	=	72·55	Calderon.
	1·049	=	69·96	Weiss.

The factor of Weiss may safely be ignored. That of Calderon is remarkable. It is deduced from determinations made by him in Berthelot's laboratory with the view of revising that chemist's value for Sj (=73·8). Calderon found, for 10 to 20 per cent solutions of cane-sugar, $S_D = 67·1°$ and $Sj = 73·2°$.* Brown and Heron do not state the grounds of their adoption of the ratio employed by them. The mean of the first three results is $Sj = +73·98°$, a value practically identical with 74·0. The mean of the first five results is $Sj = +73·72°$.

The foregoing conflicting results of determinations of specific rotatory power may be advantageously pondered by those observers who are never tired of telling of the extreme accuracy with which polarimetric readings may be made.

Since my last letter appeared and this one was commenced I am glad to see that Mr. T. Bayley (page 233) has published some interesting determinations of the value of S_D for invert-sugar. If he or some other chemist having extensive practice in polarimetric observations will determine the value of S_D for invert-sugar under various conditions as to the *concentration* of the solution, proportion and strength of acid employed, and time and temperature employed for inversion, instead of blindly following the prescribed directions, it will be doing essential service.—I am, &c.,

Alfred H. Allen.

Sheffield, November 8, 1880.

Postscript.—The above letter was written and in type before that of Mr. J. Steiner appeared in your columns. It will be apparent that Mr. Steiner and myself have independently been writing to much the same effect. The fact that the correspondence should have led to the publication of such a valuable letter as that of Mr. Steiner is sufficient proof that the subject required ventilation.—A. H. A.

November 22, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 17, October 26, 1880.

Application of Selenium to the Construction of a Photo-electric Regulator of Heat for Baking Stained Glass.—P. Germain.—The author has taken advantage of the different influences exerted upon the electric resistance of this body by the different rays of the spectrum.

* *Comptes Rendus*, lxxxiii., 393.

Certain Modifications Undergone by Glass.—J. Salleron.—The author often meets with well-made thermometers, the indications of which are erroneous to 8° or 10°, or more. Such changes occur at printing ink works, where oils are heated for several days to 270°; in glycerin works, and with rectifiers of benzol. Glass is not merely modified when heated to 300°; it undergoes true deformations at far lower temperatures. Thus the hydrometers used in sugar works, which are often exposed for a considerable time to temperatures of 95°, are affected. After an immersion of some days they are completely modified; their weight decreases, and they become erroneous to the extent of 7° or 8° B. [In many chemical works it has been found necessary to submit all hydrometers used for hot liquids to a weekly comparison with a standard instrument.—*Ed.* C.N.]

No. 18, November 2, 1880.

Heat of Formation of the Ethers Formed by the Hydracids.—M. Berthelot.—The author's experiments relate to the hydrochloric, hydrobromic, and hydriodic ethers of methyl and ethyl.

Heat of Formation of Carbon Disulphide.—M. Berthelot.—This compound is formed from its solid elements with absorption of heat, but it is probable that if formed from gaseous carbon and sulphur, heat would be liberated.

Application of the Photophone to the Study of the Noises taking place on the Surface of the Sun.—A. Graham Bell.—On visiting the observatory of Meudon, at the invitation of M. Janssen, Mr. Graham Bell examined with much care the large photographs which are being made there for the study of the solar surface. M. Janssen having informed him that he detected movements of a prodigious rapidity in the photospheric matter, Mr. Bell had the idea of employing the photophone for the reproduction of the sounds which these movements must necessarily produce on the surface of the sun. M. Janssen approved of the idea, and requested Mr. Bell to attempt its realisation at Meudon, placing all the instruments of the observatory at his disposal. The weather being very fine on Saturday last (October 30), Mr. Bell came to Meudon to attempt the experiment. A large solar image of 0·65 metre in diameter was examined with the selenium cylinder. The phenomena were not sufficiently decided to be regarded as successful, but Mr. Bell does not despair of succeeding on further examination. M. Janssen suggested that the chance of success would be much greater if in place of directly interrogating the solar image where the variations which are produced, though responding to considerable changes on the sun's surface, are not sufficiently rapid even in the most powerful instruments to cause the production of sounds in the photophone, a series of solar photographs of one and the same spot, taken at sufficient intervals to obtain well-marked variations in the condition of the spot, might be passed with a suitable rapidity before an object glass, which would give conjugated images upon the selenium apparatus. This would be a means of condensing into a time as brief as could be desired the variations which in solar images are much too slow to give rise to a sound. M. Janssen has placed himself at Mr. Bell's disposal to provide him with solar photographs suitable for carrying out this idea, and the latter has sent M. Janssen the photophonic apparatus requisite. It has appeared to M. Janssen that the idea of reproducing on earth the sounds caused by great phenomena on the surface of the sun was so important that the author's priority should be at once secured.

Oxidation of Mannite.—J. A. Pabst.—Mannite yields on oxidation a tribasic of the formula $C_6H_8O_9$.

Ferments of the Albuminoid Matters.—M. Duclaux.—These ferments are ærobian, anærobian, or both. If cultivated in milk they transform the caseine into soluble albuminoids. That which the ærobian forms effect by a slow and regular action, the anærobian accomplish by disengaging carbonic acid and hydrogen, a portion of

which becomes hydrogen sulphide and phosphide, the mass taking a putrid taste and smell.

Gazzetta Chimica Italiana.
Anno 10, Fasc. 3 and 4, 1880.

Ulmic Materials Produced by the Action of Acids upon Sugar.—F. Sestini.—The formulæ ascribed by Mulder to the ulmic products which had been dried at from 140° to 165° before being submitted to combustion are not admissible, since, at temperatures above 100°, these bodies lose a notable quantity of volatile matter, and in particular of formic acid. The ulmic substances obtained by the action of dilute sulphuric acid upon sugar, and which may be called sacchulmine, appear in the form of minute yellowish brown globules. On treatment with a cold aqueous solution of caustic potassa, sacchulmine gives off an acid principle derived from the action of sulphuric acid upon glucose. The ulmic matter (sacchulmine) insoluble in cold alkaline liquids is derived directly from saccharose. In the ulmification of sugar there is evolved a considerable quantity of volatile acids, especially formic acid.

Certain Derivatives of β-Chloro-butyric Acid.—Luigi Balbiano.—This paper is chiefly devoted to an examination of β-amido-butyric acid, and of the action of aniline upon β-chloro-butyric ether.

The Diffusion and the Physiological Condition of Copper in the Animal Organism, declared for the first time by Bartolomeo Bizio and vindicated by Prof. Giovanni Bizio.—The author seeks to prove that his father, Bartolomeo Bizio, was the original discoverer of the normal occurrence of copper in the animal economy.

Chemical Constituents of Stereocaulon Vesuvianum.—Emanuele Paterno.—The question is raised whether the succinic acid obtained from this lichen is a product of the decomposition of atranoric acid, which, however, on treatment with baryta, furnishes a product totally different.

Correspondenz-Blatt des Vereines Analytischer Chemiker.
No. 15.

Detection of Honey Sophisticated with Starch-Sugar.—A. Planta.—The author determines the grape-sugar present in honey before and after inversion. In pure honey, the proportion of pre-existing grape-sugar is from 63 to 71, whilst in sophisticated samples it is 29 to 37. But the starch-sugars of commerce contain a much higher proportion of pure grape-sugar than he assumes.

Determination of Sulphur in the Products of the Iron-Manufacture in Ores and Fuel.—A. Kollert.—From the *Chem. Central-Blatt.*

Simple Method for Determining the Temporary Hardness of Water.—A. Wartha.—The most accurate method is to titrate at a boil in a silver capsule with normal hydrochloric acid, using as indicator solution of alizarin or extract of logwood. As a more convenient method when travelling, &c., the author uses a tube 30 to 40 c.m. in length, closed and rounded at one end, and with a lower mark showing 10 c.c. From this mark, upwards towards the mouth, the tube is graduated in 0·1 of a c.c. For use, the tube is filled up to the lowest mark with water in question and a little piece of filter-paper is added which has been previously saturated with extract of logwood and dried again. This gives the water a violet colour. Centinormal hydrochloric acid is then added from a dropping bottle till the colour of the liquid approaches an orange. The tube is then closed with the thumb and well shaken. Carbonic acid escapes, and the liquid grows red again, Acid is again added, and the tube is again shaken till a single drop of acid changes the colour of the liquid to a pure lemon yellow. The quantity of centinormal acid used is then read off on the graduated tube, and can be calculated into calcium carbonate.

MISCELLANEOUS.

Adulteration of Food.—The following was cabled from New York on the 15th November inst.:—The First Prize of 500 dols., offered by the National Board of Trade of the United States of America, for the best Essay and Draft of an Act to prevent injurious Adulteration and regulate the Sale of Food without imposing unnecessary burdens upon commerce, has been awarded to Mr. G. W. Wigner, F.C.S., F.I.C., Honorary Secretary of the Society of Public Analysts, &c., of London, England.

Chemical Constitution of Milk.—Dr. N. Gerber.—Caseine is not a homogeneous albuminoid, but a mixture of albumen and protalb-bodies which appear as transition-stages in peptonisation. In the milk globules has been found an albumenoid which constitutes the serum. In the curd are met with an albuminous body identical with the stromæi alb-compound of the globules, a body which Danilewsky and Radenhausen name orroproteine and two series of peptones. Hence it is no longer proper in milk-analysis to speak of caseine and albumen, but rather of albuminates.—*Correspondenz-Blatt*, 13, 1880.

NOTES AND QUERIES.

Analysis of Oils.—Would you kindly inform me of the best treatise on the analysis of oils, tallow, and lubricants generally, and where such a book may be procured?—R. T.

Preventing Iron from Rusting.—In making some photographic experiments I find that iron and steel do not rust when immersed in solutions of caustic soda and caustic potash, but cannot discover any explanation of the fact in books to which I have access. Would you kindly, therefore, in your answers to correspondents, next issue, favour an earnest student with the reason of the phenomenon, and say whether any other solutions protect those metals from oxidation. I cannot understand why the alkali in the solution prevents the oxygen in the water acting on the iron or steel.—A.B.

MEETINGS FOR THE WEEK.

MONDAY, 29th.—Medical, 8.30.
—— Society of Arts, 8. "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain," by A. H. Church, F.C.S.
TUESDAY, 30th.—Civil Engineers, 8.
—— Royal, 4.30. (Anniversary.)
WEDNESDAY, Dec. 1st.—Society of Arts, 8. "The Photophone," by Prof. Alexander Graham Bell.
—— Geological, 8.
—— Pharmaceutical, 8.
THURSDAY, 2nd.—Chemical, 8. "Communication from the Laboratory of the University College, Bristol," by W. Ramsey. "On the Specific Volume of Chloral," by Laura Maude Passavant. "On the Formation of Carbon Tetra-bromide in the Manufacture of Bromide," by J. W. Hamilton. Ballot for the Election of Fellows.
FRIDAY, 3rd.—Geologists' Association, 8.

TO CORRESPONDENTS.

D. E.—Consult some standard work on Quantitative Analysis.

THE CHEMICAL NEWS
AND
JOURNAL OF PHYSICAL SCIENCE.

Edited by WILLIAM CROOKES, F.R.S.

Published every Friday. Price 4d. Annual Subscription, post free, including Indices, £1

CHARGES FOR ADVERTISEMENTS.

	£	s.	d.
Five lines in column (about 10 words to line)	0	3	6
Each additional line	0	0	6
Whole column	1	15	0
Whole page	3	0	0

A reduction made for a series of insertions.

Cheques and Post-Office Orders, crossed "London and County Bank," payable to the order of William Crookes.

BOY COURT, LUDGATE HILL LONDON, E.C.

SPECIALITIES.

MANGANESE—Finest Crystallised, Lump, Ground, and Granulated of every quality, and Prepared for *Chlorine, Glass, Steel, Ferro-Manganese Pottery, Battery*, and Every Purpose.

BAUXITE—(Hydrate of Alumina) Of high percentage of Alumina and almost free from Iron: The Cheapest, Best, and Most Profitable article from which to produce Alum, Alum Cake, and Sulphate of Alumina, &c. [BRAND, "IRISH HILL BAUXITE."]

FLUOR-SPAR—Of the Very Finest Quality for Acid, Soda, Glass Flux, and all purposes.

BARYTES—(Carbonate and Sulphate.) Crystallised, Selected Lump and Ground for all uses.

CRYOLITE—Magnesite, Felspar, Arsenic, Phosphates, French Chalk, Strontia, Wolfram, Chromic, Terra Alba, Rotten Stone, China Clay, Umbers Ochres, Antimony, Calamine, Emery Stone all Oxides, and all

FULLER'S EARTH—Of superior quality, and entirely free from grit. [BRAND, "EMERALD."]

MINERALS, CHEMICALS, AND COLOURS.

GEO. G. BLACKWELL,

MINE PROPRIETOR,

Manganese and Mineral Works, Grinding Mills, and Ore Yards, GARSTON.

OFFICES—26 CHAPEL STREET, LIVERPOOL.

TETRACHLORIDE OF CARBON.
BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

JESSE FISHER & SON,
Phœnix Chemical Works Ironbridge.

Established 1798.

ROBERT DAGLISH & CO.,

ENGINEERS, BOILER AND BRIDGE MAKERS, MILLWRIGHTS,

BRASS AND IRON FOUNDERS.

Manufacturers of every description of Condensing, or High-pressure Blowing, Pumping, Rolling, Winding, and Patent Steam-engines, of any required power, for Irrigating, Draining, Mining, Rolling Mills, or Water Works purposes, and Manufacturers of every description of Chemical, Colliery, Copper Ore, Gold Mining, Glass, and Rock-salt Machinery.

Black-ash Revolving Furnaces of the Most Approved Type.
Bessemer Steel-Rail Plant.
Compressing-Engines for Collieries, Iron Works, and Weldon's Patent Bleaching-Powder Process.
Caustic, Chlorate, Decomposing, Nitre, Nitro-Glycerine, Iodine Potash, Sulphur, Acid, and Oxalic Pans.
Gas Producers Patent for Heating and other Purposes.
Pyrites Burners for Irish, Norwegian, and Spanish Ores Improved Construction.
Patent Rousing Machinery for Brewers.
Retorts, Acid, Gas, Iodine, Nitric, Nitre, Nitro-Glycerine and Vitriol Refining.
Steam Superheaters improved for Oil, Tar, and Resin Refining.
Steam Sulphur Melter.
Stills for Oil, Resin, and Tar.
Wheels, Bevel, Mitre, and Spur Moulded on the Shortest Notice by Patent Machinery.
Makers of Mactear's Patent Carbonating Furnace, Jones and Walsh's Patent Sulphate of Soda Furnace, Parnell and Simpson's Patent Causticiser, and Kynaston's Patent Alum Plant.

Lists sent on Application.

Photographs, Plans, and other information supplied on receipt of Order.

ST HELEN'S ENGINE, BOILER, AND BRIDGE WORKS AND FOUNDRY,
LANCASHIRE.

GREENBANK ALKALI WORKS COMPANY (LIMITED),

ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{2}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application. Orders for small quantities executed for Cash against Invoice.

BAILEY'S PATENT HOT-AIR ENGINE.

Made from ¼ to 5 horse-power. 56lbs. of coke will keep a 1-horse going 12 hours. 1000 galls. of water lifted 50 feet high for a penny.

NO BOILER. NO DANGER.

Awarded Prize Medal by the chief Societies.

SOLE MAKERS—
W. H. BAILEY & Co., Albion Works, Salford, Manchester.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA.

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

BISULPHIDE OF CARBON.

CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,
161, 162, 163, Palmerston Buildings, London, E.C.

THE CHEMICAL NEWS.

VOL. XLII. No. 1097.

NOTE ON THE ATOMIC WEIGHT OF GLUCINUM, OR BERYLLIUM.

By J. EMERSON REYNOLDS, M.D., F.R.S.

THE present position of this much discussed question has been stated so clearly by Mr. Humpidge in the CHEMICAL NEWS, vol. xlii., p. 261, that, for the purposes of this note, I shall partially adopt his account of the results of my earlier experiments and those of MM. Nilson and Pettersen, and proceed to give the details asked for concerning my first observations. In doing so, however, I have no intention to refer to my later results, which will be published in full in due course, or to enter upon the discussion of the side questions raised by L. Meyer, Brauner, and others, although I think Mr. Humpidge underrates the importance of Meyer's criticism of MM. Nilson and Pettersen's last results.

I may remark in passing that the latest experiments of the Swedish chemists afford some ground for a suspicion I have long entertained, that in the earlier experiments on both sides we have possibly dealt with two forms of the same substance. The literature relating to glucinum contains the records of a particularly large number of differences of opinion amongst chemists of equal skill and ability; it may be that they but indicate some real differences in matter.

Preparation of Pure Glucina or Beryllia.—The material operated upon was the product obtained from Donegal beryl by the well-known method of fusion with alkaline carbonate and subsequent treatment with hydrochloric acid; separation of most of the silica by evaporation, extraction of the earths again with acid, addition of chlorine water, and precipitation of all the iron and a small proportion of the earthy hydrates by ammonia carefully added. Aluminic and glucinic hydrates were then precipitated from the iron-free filtrate by excess of ammonia, and the mixed hydrates, after thorough washing, were digested for a week with a large excess of nearly saturated cold solution of ammonium carbonate. The glucinic solution was then filtered from the undissolved alumina, distilled to dryness, and the residue thoroughly washed with boiling water, and heated to redness. The glucina thus obtained still contained silica and alumina, and the method followed in its purification was that recommended by Dr. Wolcott Gibbs,* and is the only process known to me that affords a perfectly pure product. It consisted in fusion of the glucina with excess of double fluoride of hydrogen and potassium in a large platinum dish. The product was extracted with boiling water and the solution filtered through paper supported by a platinum cone; the filtrate was received in a platinum dish, and it then deposited crystals of the double fluoride of glucinum and potassium. The aluminium was left on the filter in the form of fluoride of aluminium and potassium. The potassio-glucinic fluoride was purified by recrystallisation, and the pure hydrate obtained from it in the following way:—The pure salt was heated in a platinum dish with pure sulphuric acid until all hydrofluoric acid was expelled, and along with it every possible trace of silica; the residual sulphate was then poured into water, precipitated by ammonia, thoroughly washed, and dried. In this way the perfectly pure oxide was obtained that was employed in my experiments.

* *American Journal of Science* [2], vol. xxxvii., p. 356.

Conversion of Oxide into Chloride.—The dried hydrate obtained as above was mixed with half its weight of sugar charcoal, and then heated strongly in a platinum crucible. The residue was mixed with oil free from lead, and made into balls, which latter were heated to redness in a platinum crucible. The somewhat friable lumps thus obtained were transferred to a porcelain tube, and heated to full redness in a current of washed and dried chlorine gas. The pure white chloride was tested in the following way:—A portion was added to water acidulated with hydrochloric acid, and, when all dissolved, a saturated solution of ammonium carbonate was added in excess. The precipitate first formed soon dissolved in excess, and no cloud appeared on standing; therefore alumina had not been taken up from the tube. The absence of silica was proved by evaporating the aqueous solution of the chloride to dryness, heating to 150° C., and taking up the residue with hydrochloric acid in which it was completely soluble.

Reduction of the Chloride.—A platinum crucible was lined as completely as possible with the pure chloride; a mixture of the latter with one-third of its weight of clean metallic sodium in small pieces was then introduced, covered with a layer of pure chloride, and a piece of lime used as a lid for the crucible. The temperature was not allowed to rise so high as to liquefy the mass, and on removal of the material from the crucible those portions that had been in contact with the sides were rejected. The rest was then placed in a small lime crucible, covered with pure sodium chloride, and heated strongly. On breaking the crucible a small coherent mass was obtained after washing away all soluble matter. There was great loss in this operation, as much of the finely-divided glucinum, or beryllium, had been carried into the porous lime; hence it would be very difficult and costly to prepare even 2 or 3 grms. in this way. The semi-fused mass obtained in this operation was carefully cleaned from adherent oxide, and was then reduced by trimming under a magnifier to a little over 2 decigrms. The small piece of beryllium thus prepared, and used in the determination to be presently described, was certainly free from aluminium and silicon. The importance of excluding the latter is evident when it is remembered that beryllium can unite with a large proportion of silicon,* and is said even to reduce the latter from silicates. As stated in my paper I suspected the presence of platinum in the metal, and after the publication of the results I dissolved my sample of metal in hydrochloric acid, when a minute proportion of a dark powder was left, which proved to be platinum. The total weight of beryllium then at my disposal was so small that an estimation of the platinum in it was out of the question. The beryllium solution was tested for iron, and it gave a very faint reaction for that metal. I much regret that it did not occur to me until long after the solution of my metal to examine it for any possible alloy with sodium.

Characters of the Metal.—The mass when burnished showed a somewhat silvery lustre. When air was removed it sank in a solution† whose specific gravity = 2. Its specific gravity was therefore greater than 2, but very slightly higher, as it did not sink in a solution whose specific gravity was 2·13. It did not seem to decompose water in the cold and on standing for a short time. It was soluble in dilute hydrochloric acid, and was attacked by potash. Therefore, so far as could be ascertained with the small quantity at my disposal, the metal agreed in characters with that previously obtained by Debray. I did not observe any trace of crystalline structure in the material. The sample of metal that possessed these characters was exhibited at the meeting of the last British Association at Glasgow.

First Determination of Atomic Heat.—It is not quite correct to refer to my experiments as estimations of specific

* As much as 20 per cent of silicon.

† Of mercuric iodide in potassic iodide.

heat. All that I have made with beryllium aimed at the determination of the weight of the metal that contained at 100° C. the same quantity of heat as a centigramme atom of pure silver at the same temperature. The specific heat was then *calculated* from the data obtained.

I may state here that when I began my experiments with glucinum, or beryllium, any mental bias of which I was conscious was in favour of the atomic weight 13·8 rather than 9·2, owing chiefly to the frequent occurrence of 3Be in formulæ which represented the metal as a diad with the lower atomic weight. But in the first comparative calorimetric experiments described below, 9·2 centigrms. were taken as the mean between the equivalent of the metal (4·6) and 13·6, and therefore a convenient weight to begin with. My paper contains a sufficiently full description of the apparatus in which the above comparison was made: it was essentially a spirit-thermometer with a test-tube sealed into the bulb. I have lately improved the little instrument, and made a very convenient *atometer;* but this form will be described in another communication. The measurements I shall now give were obtained with the first apparatus made.

Three metals were compared in the instrument, namely, pure silver, pure aluminium, and the beryllium, which latter I had at least endeavoured to obtain in a pure condition. When a centigrm. atom of silver was heated in the steam-bath used by Bunsen for the same purpose, and dropped into the tube by the calorimeter, which contained 1 cubic centimetre of water, the thread of mercury in the graduated stem of the instrument rose through 122 units of the arbitrary scale. The silver was removed, as in Bunsen's excellent method, the metal again heated to the same temperature, and again dropped into the calorimeter, which had meanwhile been gradually cooled to the original starting-point. Four experiments thus made gave the following expansions:—

Expt. 1	122
,, 2	120
,, 3	125
,, 4	124
Mean	122·7

A pair of similar experiments was made with 27·5 centigrms. of aluminium, under the same conditions as regards temperature and starting-point on the scale. The following numbers were obtained:—

Expt. 1	127
,, 2	130
Mean	128·5

In the case of the smaller mass of aluminium there was probably less loss of heat in transference to the calorimeter, hence the higher value obtained. A corresponding difference is observed in the case of magnesium.

Another pair of experiments was made with 9·2 centigrms. of the beryllium. The readings were:—

Expt. 1	120
,, 2	116
Mean	118

These numbers seemed sufficiently to distinguish between the weights 9·2 and 13·8, for if the latter were the true atomic weight, the expansion caused by 9·2 c.grms. of metal ought not to exceed some 80 measures of my scale.

If we take the atomic heat of silver as 6·15, that of beryllium would be as nearly as possible 5·91.

It has been objected, however, that the comparison of weights so widely different is unsatisfactory, and there is no doubt that the experiments show a tendency to exaggeration of atomic heat in the case of aluminium. But this objection is diminished in force if aluminium be taken as the standard, and its atomic heat be represented by the number 5·84. On this scale, even accepting the highest reading for aluminium and the lowest for beryllium, the atomic heat of the latter is 5·2.

I have no desire to press these results beyond their legitimate bounds, nor do I wish to depreciate the value of the determinations made by MM. Nilson and Pettersen, for those only who have had much experience with beryllium and its compounds can fairly estimate the difficulties surrounding the investigation and the perplexing character of the results often obtained. At the same time I do not think that chemists are likely to accept as decisive a determination of specific heat made with a metal containing nearly 13 per cent of impurity! Although corrections were applied for these impurities, we have no evidence as to their condition in the specimen. Any impurity in my metal was likely to *lower*, not to raise the specific heat.

The question arises, however, whether there may not be some connecting links between the two groups of experiments: in other words, whether we may not have dealt with the same matter, but in different states of aggregation. Nilson and Pettersen's metal was in distinct crystals: mine did not exhibit any crystalline structure. Now, as a rule, to which there are comparatively few exceptions, the specific heat is lower in the crystalline than in the uncrystalline form, and even difference of crystalline form is marked, as in the case of tin, by change of specific heat. This will appear from the following table:—

Element.	Specific Heat.
Sulphur crystals	0·1776
,, recently fused	0·2025
Carbon—animal, black, pure	0·2608
,, wood charcoal	0·2415
,, graphite	0·2018
,, diamond	0·1468
Selenium—"metallic"	0·0761
,, vitreous	0·1031
Tin—cast	0·0559
,, allotropic	0·0545

The wide differences observed in some of these cases are in the same direction as are those between the beryllium results: it is at least possible that the cause may be similar in all cases. However, this question cannot be definitely settled until we succeed in preparing a good lump of homogeneous beryllium in a pure state. Until this is accomplished, and the question finally decided, we are likely to keep to our respective atomic weights for beryllium.

Trinity College, Dublin.

MATERIALS CONTAINING TANNIN USED IN JAPAN.*

By I. ISHIKAWA,
Graduate of the University of Tokio.

Numerous methods have been proposed for the purpose of estimating tannin, but none are free from objections, and few of them give really trustworthy results. That method which has been received with most favour is Löwenthal's, which is based upon the oxidation of the tannin by means of a solution of potassic permanganate. The tannin is found to be completely oxidised when a certain weight of indigo-carmine added has lost its colour, and this acts as an indicator. Knowing the amount of permanganate required to oxidise the indigo-carmine alone, the amount required to oxidise tannin and gallic acid, and other things present, is found by difference. The tannin is then removed by means of gelatin, and the number of cubic centimetres of potassic permanganate still required is deducted from the total amount, the difference being a measure of the amount of tannin in solution. In using this method it is evident that the amount of permanganate equivalent to a certain weight of pure tannin must be accurately known. This equivalent was determined by

* Abstract of a thesis presented on graduating, July, 1880.

Neubauer, who employed tannin from nut-galls, and found that a litre of permanganate of potassium solution, which required 6·3 grms. of oxalic acid to completely decolourise it, used 4·157 grms. of tannin. Oser, who used tannin from oak-bark, found that a litre of permanganate of the same strength as above required 6·236 grms. of tannin, so that nut-gall tannin decolourises 1½ times as much permanganate as oak-bark tannin. Löwenthal's process is, therefore, at present only applicable to the determination of the two tannins above mentioned, and if employed for the assay of other tannin materials the results only give the amount of tannin in terms of one or other of the two just mentioned.

In examining the series of tannin matter used in Japan, I have employed Löwenthal's method, and the percentage numbers express the amounts of tannin in terms of the tannin of Japanese gall-nuts. As it was not certain that the permanganate equivalent of the tannin contained in them was the same as that contained in the European variety, I first carefully determined the amount of permanganate necessary to oxidise a given weight of the purified tannin.

Preparation of the Tannin.—A quantity of powdered Japanese gall-nuts was placed in a percolating apparatus, and treated with a mixture of alcohol and ether the percolate afterwards separating into two layers. The upper ethereal layer was carefully decanted, and the aqueous solution was evaporated on the water-bath. The residue was treated with hot water, and filtered from some insoluble matter, and from the filtrate the tannin was fractionally precipitated by acetate of lead, the first and last portions being rejected. The tannate of lead was then decomposed by means of an insufficient quantity of oxalic acid, as recommended by Löwenthal. The solution finally obtained was evaporated first over the water-bath, afterwards *in vacuo*. The tannin thus obtained was a light porous mass of a pale yellow colour.

The potassic permanganate solution was made so that 1 c.c. exactly corresponded with 1 c c. of a solution of oxalic acid containing 6·3 grm. $C_2H_2O_4.2aq$ in 1 litre. The indigo solution was prepared by treating indigo with fuming oil of vitriol, diluting with water and filtering.

Process.—1·2 grms. of tannin were dissolved in 250 c.c. of water. Of this solution an aliquot portion was added to a large volume of water containing a known amount of indigo solution and sulphuric acid. The permanganate solution was added drop by drop to this mixture until the deep blue colour of the indigo changed to a clear golden-yellow. A separate determination of the amount of permanganate required to decolourise the indigo alone was made, and this number was deducted from the total number above obtained.

The following are the details:—25 e.c. of the indigo solution and 10 c.c. of sulphuric acid were diluted with water, and required, in five separate determinations, 21·25, 21·15, 21·13, 21·20, 21·10 c.c. of permanganate; average, 21·166 c.c.

A similar mixture, with the addition of 10 c.c. of the above tannin solution, was examined. Required in five experiments:—32·73, 32·67, 32·60, 32·70, 32·70; average, 32·68. Required for the tannin, therefore, 32·68 – 21·166 = 11·514 c.c.

One litre of the permanate solution thus corresponds with 4·1688 grms. of tannin. This number is sufficiently near to that (4·157 grms.) obtained by Neubauer.

Determination of the Tannin in Barks.—Besides the solutions already mentioned, two others are required—1st. A solution of gelatin. 25 grms. of gelatin, well swollen in cold water, were melted over the water-bath, and diluted to 1 litre with a saturated solution of sodic chloride. 2nd. A saturated solution of sodic chloride. This solution contained in 1 litre 25 c.c. of oil of vitriol. The assay is then conducted as follows:—5 to 10 grms. of the rasped bark are exhausted with boiling water, and the solution when cold made up to half a litre. Of this solution 10 or 20 c.c. are taken according to the richness in tannin, mixed with a considerable volume of water containing known amount of indigo solution and sulphuric acid, and the amount of permanganate required to decolourise the solution ascertained. The next step is to precipitate the tannin from another portion of the solution, and to estimate the effect of the gallic acid and other impurities upon the permanganate. 100 c.c. of the tannin solution are mixed with 50 c.c. of the salted gelatin: after well stirring, 100 c.c. of the salt solution are added, and the mixture allowed to stand over night. After filtering, an aliquot portion is mixed with indigo, and tested with permanganate as before. In presence of salt the action of the permanganate on gelatin may be neglected. Allowing for the indigo added in both cases, and deducting the number of c.c. of permanganate used in the second experiment from that used for the same number of c.c. of tannin solutions before precipitation, the amount of tannin present is found by using the equivalent before determined.

Enumeration of Tannin Materials.

1. *Kibushi, or Gall-nuts.*—This stands first in import ance. It is also known as *fushi*, and in old writings as *mimi-fushi*, and is the excrescence produced on the *Rhus semialata* by the puncture of an insect. According to the botanist, Ranzan, the tree grows wild in the plains and among mountains, but it is only upon the latter kind that the excrescence is found. The best product is found on trees growing in moist places. The form of the gall-nut is very irregular, and its surface is covered with small bosses. It is hollow, and contains inside the eggs of the insect. It varies in size, from about half an inch to one-and-a-half inches in length, and somewhat less in breadth. The thickness of the walls ranges between 1 and 2 millimetres. In texture it is hard and horny, but frequently parts of it are quite friable, and of an opaque white appearance. When freshly gathered its colour is yellow, but on keeping it assumes a grey colour, and its surface is of a velvety appearance.

In the Tokio market only the Japanese product is now met with, but about eight or nine years ago considerable quantities were imported from China. I was fortunate enough, on a visit to Kiyoto, to obtain a specimen of the Chinese variety, the percentage of tannin in which is given at the end. In appearance it is quite different from the Japanese; it is larger, and its surface is wanting in the projections characteristic of the Japanese gall-nut. It is either spherical or oblong, harder and stronger in texture, and the thickness of the walls is three or four times greater than that of the Japanese.

The gall-nuts found on the markets of Osaka and Kiyoto come from the neighbouring provinces of Kii, Bichû, Tango. In Tokio we find gall-nuts from Chichifu and other districts. The galls are gathered in July, August, or September. They are plucked, placed in wooden tubs, and boiling water added, which is left for half an hour; after which they are removed, and dried in the sun for three or four days. From the analysis it will be seen that the percentage of tannin varies considerably. The dyers usually prefer the old kinds, which they say are stronger. In Kiyoto they are kept in storehouses for years before being used. The old varieties are more brittle, and yield darker decoctions. In the specimens from Kii it will be seen that the older kind contains 65·26 per cent, while the younger variety has only 60·9 per cent tannin.

The reactions given by a solution of the Japanese gall-nut are identical with those given by Aleppo galls.

2. *Yasha-Bushi* and *Han-no-ki.*—Yasha-bushi (alder fruits), frequently called *Yasha* only, is the fruit of the *Alnus firma*, which grows mainly in the provinces of Totomi, Idzu, Kai, and Iwaki. It is sold by the name of the province from which it comes, as, for example, Idzu Yasha. Some confusion appears to exist as to the species of *Alnus* from which the fruit is obtained. That which is sent to the market, and which contains most tannin, is the species above-mentioned, *A. firma*, but the fruit of the *A. maritima* (or Han-no-mi) is used to a small extent. The bark of this species is also used.

The decoction of this fruit is dark, and contains a large amount of resinous matter, and gives a dirty yellow precipitate with acetate of lead. The original solution gives a greenish black precipitate with ferric salts, but after partial purification it yields a bluish black precipitate. The analyses of two specimens given show that it contains muchf less tannin than the gall-nuts, but it is richer than most o the barks.

3. *Yobaihi* or *Shibuki.*—This is the bark of the Yamamomo-no-ki (*Myrica rubra*), which grows in many parts of Japan—Kii, Josa, Isć, Totomi, Idzu, and other warm provinces: that brought from Loochoo is, however, most highly esteemed. The thickness of the latter is two or three times as much as that found in this island, and, as will be seen, the percentage of tannin is greater. Besides the tannin, which gives a bluish black precipitate with ferric salts, the bark contains a body giving a yellow precipitate with acetate of lead. This dissolves in water, more easily in alcohol, and still more so in ether. By this means it can be obtained free from tannin.

4. *Zakuro*, Pomegranate rind.—The *Pumica granatum*, the fruit of which is known as the pomegranate, grows largely in the province of Kii, and is imported thence into Tokio. As sold it forms hard pieces of a beautiful yellow colour on the broken surfaces. The decoction gives a bluish black precipitate with ferric salts, and a yellow one with acetate of lead. The yellow body is soluble in ether, and can be extracted by that reagent. The rind is seldom used alone, but generally in conjunction with gall-nuts, for producing blacks on cloth, the presence of the yellow being considered by dyers to improve the appearance.

5. *Mangrove Bark* (Jap. Tangara) and *Betel-nut* (Binroji) are imported in small quantities from China and the south of Asia, but their use is extremely limited. The amount of tannin in one specimen of betel-nut is given in the table.

6. *Kashiwa Kawa* (oak-bark).—This, the bark of the *Quercus dentata*, is sometimes known amongst tanners by the same name as is given by dyers to the bark of the *Myrica rufra*, *i.e.*, *Shibuki*, and some confusion is therefore liable to arise between. The bark found in Tokio comes mainly from the provinces of Shimodzuke and Sasami, and from the mountainous districts of Musashi, the latter variety being highly esteemed. Although it contains only a small percentage of tannin—calculated as gallo-tannic acid—it is the cheapest and most abundant material found in Japan. It is mainly used in tanning and for giving strength and durability to fishing-nets. The bark of the *Quercus cuspidata* is also used. It is called Shii-Kawa.

7. *Kaki-no-shibu.*—The next material to be mentioned is not used in dyeing at all, but only as an antiseptic. This is a liquid called *Kaki-no-shibu*, and is the juice of certain varieties of the *Persimmon*, the fruit of the *Diospyros kaki*. The edible *Persimmon*, when quite ripe, is very sweet to the taste, but when unripe is very astringent: other varieties even in the mature condition do not lose their astringency. By drying in the sun, the skin being first removed, even these varieties become quite sweet, the tannin apparently disappearing completely. The *Kaki-no-shibu* is always prepared from the latter variety. The fruit is gathered early in the summer, and is beaten in stone mortars. It is next transferred to wooden tubs, in which the mass is covered with water, and allowed to stand for half-a-day. After this it is filtered through a straw bag, and the milky juice thus obtained is known as the best *shibu*. The residue in the bag is treated once more in the same way. The juice is milky at first, but it soon grows darker when exposed to the air and light, and then a thin film forms on the exposed surface. As sold it is a light or dark grey liquid holding minute particles of solid matter in suspension. It is strongly acid towards litmus-paper, gives a copious white precipitate with gelatin, and has a very unpleasant smell. When allowed to stand it deposits gummy particles.

The applications of this liquid are numerous. Whenever a substance is to be rendered unchangeable in the air it is washed over with the juice, and then becomes permanent and much stronger. It is especially used for giving strength and durability to paper, which is applied in Japan to a great many more purpose than in Europe.

The first question which may be asked is, how the juice causes the material covered with it to become stronger and more durable? In one specimen of the juice which I examined the total solid matter amounted to 64·6 grms. in 1 litre, of which more than one-half was tannin. The antiseptic properties of tannin are well known, but it does not seem that the presence of the tannin is sufficient to account for the great change in the character of the paper which actually takes place. Besides, paper painted with other tannin solutions does not present the same properties. Nor does the effect appear to be due to the presence of albuminoids, which, slowly combining with the tannin in the pores of the paper, might form a kind of leather. The juice contains nitrogen equal to 0·18 per cent of the total residue, which would correspond to 1·1 per cent of albuminoids; but this supposition seems improbable.

During these experiments the following facts were observed, and they suggest an explanation, which I give later:—

(1.) The blackening of the milky juice is only effected in an open vessel, its colour remaining unchanged when left in closed vessels. In this respect it resembles lacquer, as observed by Mr. Ishimatsu (Chemical News, vol. xxxix., p. 113).

(2.) By exposure to the air in a flat vessel the colour becomes darker, and a membraneous film forms over its surface. The film is almost insoluble in water and alcohol, and it is not perceptibly attacked by boiling with dilute sulphuric acid.

3. When left in closed bottles with only a small space above it the thin film is formed, bnt when this has been made to sink by shaking no further formation of film takes place.

4. When the film formed in an open vessel has been removed a fresh one forms, but the production of fresh films becomes slower and slower.

5. Of the suspended matter the coarse particles settle to the bottom, but the finer ones remain suspended in the form of an emulsion. It is not cellulose, for it is insoluble in an ammoniacal solution of cupric oxide. It is but slightly soluble in alcohol, 3·4 per cent of the dried substance being dissolved by 97 per cent alcohol. It has a greyish colour, but when dried becomes black, and forms a hard mass. The properties are those of a gum resin.

6. In addition to the above-mentioned facts, the dealer stated that the juice loses its peculiar property when exposed to the air for a few months.

Taking the above facts into consideration, it is probable that the following is the true explanation of the action of this liquid upon paper and such bodies:—

(*a.*) The strength gained by the paper is due to the formation on its surface of the film above described.
(*b.*) The formation of the film is due to the presence o the small particles of gum-resin held in suspension, which, on oxidation, becomes solid and darker in colour, like lacquer. Hence the dark colour which paper so treated always possesses.
(*c.*) The tannin present acts as an antiseptic.

The peculiar smell of the juice appears to be owing to the presence of butyric acid. About half-a-litre of the liquid was distilled, 200 c.c. being collected. It had a slight acid reaction and a strong odour. Calcic carbonate was added; the liquid was filtered and evaporated to small bulk, then left *in vacuo* over oil of vitriol. A thin film appeared on the surface, and increased till it covered the whole of the liquid. The vessel was then taken out and heated; a fresh amount of solid matter appeared, as would happen if the solution contained calcic butyrate. As time pressed the liquid was merely dried up at 70° C., then heated to 140° C., by which it lost 8 per cent of its weight. 0·5190 grm. of the powder dried at 140° C. was ignited, and

0·1425 grm. of lime was obtained, equal to 19·61 per cent of calcium :—

	Obtained.	Calculated for $(C_4H_7O_2)_2Ca$.	Calculated for $(C_4H_7O_2)_2Ca.H_2O$.
Ca.. ..	19·61	18·69 p.c.	—
H_2O ..	8·00	—	7·76 p.c.

It is probable, therefore, that the volatile acid is principally butyric acid.

1. *Kibushi* (nut-galls)—

	Percentage of Tannin (Gallo-tannic acid).
Chinese	77·38
Awa (1 year old)	64 85
Minabe in Kii (2 years old)	58·82
Kii (1 year old)	60·9
Kii (8 years old)	65·26
Tango	60·44
Suruga	65·3
Musashi..	67·7

2. *Yasha-bushi* (fruit of *Alnus firma*)—

Idzu Yashi	27·53
Totomi	25·32

3. *Shibuki* (bark of *Myrica rubra*)—

Haibara, in Totomi	11·66
Tosa	10·55
Loochoo	14·96

4. *Zakuro* (rind of *Pumica granatum*)—

Kii	20·36

5. *Binroji* (betel nut) .. .. 18·03

6. *Kashiwa Kawa* (bark of *Quercus dentata*)—

Inner bark	7·4
Outer bark	2·64

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, November 27, 1880.

Prof. W. G. Adams in the Chair.

New member—H. C. Jones, F.C.S.

Prof. Graham Bell exhibited his photophone, and explained the apparatus employed by Mr. Summer Tainter and himself for transmitting sounds by a beam of light. The form in use consists of a metal plate or mirror, vibrated by the sound, and reflecting a beam of light to a distance, where it is focussed on a selenium cell in circuit with a telephone and battery. The light undulates in sympathy with the vibrations of sound, and alters the resistance of the selenium in accordance with the vibrations, thereby reproducing the sound in the telephone. The electric light used was too unsteady to give articulate speech; but by means of a rotating disc perforated round its rim with holes the light could be occulted in such a manner as to give an audible note in the telephone. Different varieties of receivers were described, some of which have not yet been tried. One of these consisted in varying the rotation of the plane of polarisation of the polarised beam. A plan for transmitting the beam consists in making the vibrating plate vary the supply of gas to a jet or manometric flame. The farthest distance speech has been heard by photophone is 800 feet, but, theoretically, it should operate better the greater the distance between the mirror and selenium. On interposing a sheet of hard rubber in the ray the invisible rays passing through it conveyed the sounds in a lower degree, and sounds can be heard by replacing the selenium receiver by discs of different materials, such as hard rubber, metal, &c., and simply listening at them. All substances appear to possess the power of becoming sonorous under the influence of varying light. Hard rubber, antimony, zinc, give the best effects; paper, glass, carbon, the worst. Even tobacco smoke in a glass test-tube held in the beam emitted a note, as also did crystals of sulphate of copper. When hard rubber was simply made into the form of an ear-tube and held in the beam the audible effect was also produced; and, in fact, when the beam was focussed in the ear itself, without any other appliance whatever, a distinct sound could be perceived.

Prof. Adams thanked Prof. Bell in the name of the Society, and called on

Mr. Shelford Bidwell, who exhibited a lecture-photophone, in which the reflector for receiving the light was discarded, and the beam focussed on the selenium by a lens. The two lenses used cost only 25s., and the beam was sent 14 feet. The selenium cell was made by spreading melted selenium over sheets of mica, and then crystallising it by heat. For mica Prof. Bell recommended microscopic glass. The resistance of the cell was 14,000 ohms in the dark, and 6500 in the light. Speech was distinctly transmitted by this apparatus.

Mr. J. Spiller thought that since selenium probably alloyed with brass and the baser metals, it would be better to use gold and silver for the cells; but Prof. Bell said that he preferred brass, since (perhaps for the reason that Mr. Spiller gave) it yielded the best results.

Dr. J. H. Gladstone read a paper "*On the Specific Refraction and Dispersion of Isomeric Bodies*," an extension of his paper of last June. He concluded that the dispersion of a body containing carbon of the higher refraction is very much greater than that of a body containing carbon of the normal refraction, 5, and that isomeric bodies which coincide in specific refraction coincide also in specific dispersion.

NEWCASTLE-NPON-TYNE CHEMICAL SOCIETY.

General Meeting, October 28, 1880.

Mr. R. C. Clapham, the Retiring President, in the Chair.

Mr. Clapham—My time of office has come to a close, and it gives me very great pleasure to introduce to you Mr. Swan, who has already made for himself a name in connection with electric lighting. It is an honour to us to have him for our President.

Mr. Swan now took the Chair.

Mr. Swan—I have to thank you for the honour you have done me in electing me as your President, though I am conscious that you might easily have chosen some one who would have fulfilled the duties of the office much more ably than I shall do. Our first business is, I think, the confirmation of the minutes of the last meeting, which I will now ask the Secretary to read.

The minutes of last meeting were now read and confirmed.

The Statement of the Treasurer (Mr. Pattinson) was read and adopted.

The Committee's report was then read and adopted.

PRESIDENT'S ADDRESS.

Ladies and Gentlemen,—In making me your President you have conferred upon me an honour which I very highly appreciate, but you have at the same time imposed on me a certain measure of duty, which, if not very onerous, is yet of a kind which I feel could have been better discharged by some other member. However, I thank you heartily for the honour you have done me, and so far as I am able I shall, with your kind help, do what I can to serve the interests of the Society.

It has been to a certain extent customary for your Presidents on the occasion of the first meeting of the session to deliver what is termed an inaugural address, and this inaugural address has for the most part taken the form of an abstract or *resumé* of the results of recent chemical research. This has been so agreeable a practice that I feel some large compensation will be demanded of me if I venture to break through the pleasant custom. Under ordinary circumstances nothing, I can assure you, would have been more to my liking than to have been your leader in the customary excursion to those regions where the latest and fairest explorations have been made, and to have shared with you the pleasure of a momentary glimpse into the newly opened-out country; but pleasant as this would have been, I think the present is an occasion when I may usefully deviate from this usage.

You are aware that I have lately been lecturing on Electric Light. For the purpose of illustrating that lecture I had conducting wires carried from the Lecture Room to Mosley Street, where I have a gas engine and dynamo-electric machines. Having those wires so near to this room, and not being certain that I can retain them in position for many days, it seemed to me, that as there are several applications of an electric current (such as I can command through these wires) more or less bearing on chemical processes, that I should probably be anticipating your wishes, and doing that which you would prefer, if, instead of delivering an inaugural address of the usual type, I were to occupy a portion of the evening by making one or two demonstrations in which the current from the dynamo-electric machine could be utilised. I have therefore had the conducting wires brought into this room. I propose to use the current in the exhibition of Jamin's Blowpipe and Siemens's Electric Furnace. Dr. Siemens has kindly lent me the furnace which he himself used—probably the one furnace of the kind in existence.

Before I proceed to these demonstrations allow me to congratulate you on so auspicious an opening of the session as this largely-attended meeting constitutes. The Society is, I think I may venture to say, in a healthier condition at this moment than at any former period of its existence. It has recently been strengthened both in the number and vigour of its members by coalescence with the Tyneside Chemical Society, a union from which I think we may anticipate much advantage in the furtherance of the objects of the Society.

Thanks to the College authorities, and especially thanks to Professors Marreco and Herschel, who have most hospitably allowed us as it were to make their "house our home," we have been relieved of all expense in respect of our place of meeting, and very much in consequence of this most generous treatment we are free from debt, or rather, I should say, our assets exceed our liabilities. I think I may also congratulate you on the prospect there is that during the session our Society will be made the organ of some valuable contributions to chemical technology. I have handed over to our Secretary (Mr. Dunn) a paper on "Bleaching Powder" by our esteemed honorary member, Professor George Lunge. I have, moreover, received through Mr. Pattinson an interesting communication from Mr. Mond with reference to the progress of alkali manufacture by the ammonia process, and I trust that there may also be forthcoming a corresponding paper from Mr. Stead bearing on the progress and development of that other great local chemical industry, the iron manufacture. I will not anticipate these contributions to our proceedings further than to remark that both the ammonia-soda process and the basic iron-smelting process are having a more rapid growth on the Continent than in England. They are, however, also growing in England. Messrs. Brunner and Mond, of Northwich, have during the last two years, by successive improvements of their plant, but without any extensions, raised their produce from 940 tons a month to 1460 tons of 58 per cent alkali. The manufacture of steel from phosphoretted pig-iron has been for some time in abeyance in Cleveland, consequent on Messrs. Bolckow, Vaughan, and Co. constructing an entirely new plant, designed to overcome some of the mechanical difficulties of the process. This new plant has during the past week been put into operation with perfectly successful results so far, and we may hope soon to have the question solved, whether the manufacture of steel from phosphoretted pig-iron by this process can successfully compete commercially with steel made by the ordinary Bessemer process from non-phosphoretted pig-iron.

These are signs of the times, and point to change in these great branches of industry; perhaps not revolutionary change, but they certainly admonish capitalists to keep a good look out, and will, I trust, stimulate the younger members of the Society to extend their knowledge beyond the pale of their routine processes, so as to adapt themselves to possible innovations and to aid in the general progress.

And now, gentlemen, I must transport you thus soon and suddenly from the region of chemistry proper to its borderland of chemical physics—too far removed, I fear some of you may think, from the alkali manufacture of the Tyne—and proceed to the demonstrations of which I spoke.

In the first place I will exhibit to you the Electrical Blowpipe of M. Jamin. Here is the apparatus. It consists, you see, of a pair of carbon pencils—an electric candle, in fat—surrounded by a coil of insulated copper wire wound a few inches distant from the pencils in the plane of their axes. The current is so led that, in circulating round the coil, it will attract the electric arc formed at the lower end of the carbon pencils, and cause it to flash out almost in the form of a fish-tail gas flame. This spreading out of the arc, is the special feature of the action of the apparatus. It facilitates the application of the heat of the electric arc to the fusion of refractory substances, and enables us better to take advantage of this little-used means of producing a very high temperature.

I have here some old scrap platinum. I will place it on the crucible, and direct the arc upon it. This blowpipe is meant to be used with an alternating current, so as to equalise the rate of burning away of the carbons. I have not an alternating current at my command, and therefore use the arrangement of commutators which you see to reverse the current by hand from time to time. You see our platinum by this time is not only melted, but boiling.

While on the subject of alternating currents, I take occasion to remark on a letter of Mr. Preece in the *Times*, referring to the death of two persons, said to have occurred through their taking hold of the wires in connection with an apparatus supplying current to Jablochkoff's candle. One of these cases occurred some time ago; the other was more recent. Now, admitting for the moment that these deaths occurred directly from the shock (which I consider by no means proved), I do not think that the extreme views put forth by Mr. Preece as to the dangers consequent on electric lighting in general can be supported, and for this reason:—The machine which supplies a Jablochkoff's candle gives alternating currents; the machines which supply the ordinary electric arc, which supply my lamps, and which are more *generally* used for lighting, give a current constant in one direction. Now, although the physiological effect of the alternating currents is undoubtedly severe, yet the effect of touching the wires from a direct-current machine is merely that you feel at the moments of making and breaking contact a slight shock, but while you have hold you feel almost nothing. [Mr. Swan afterwards demonstrated practically the harmlessness of the current by taking hold of the wires from the dynamo-electric machine for some minutes.] I think Mr. Preece, knowing how many real difficulties are connected with electric lighting, should hardly have added to these by magnifying to so great an extent the dangers which in some cases *may* accompany it.

I will now proceed to speak of Dr. Siemens's Electrical Furnace:—

I am almost afraid to try to exhibit to you in action this furnace of Dr. Siemens's, for it only reached me this morning. It came broken, and the whole day has been spent in repairing the damage, so that we have had no opportunity of trying it before hand. In connection with the exhibition of this furnace, I cannot do better than read to you his own account of it, given at a meeting of the Society of Telegraph Engineers, and reported in the Society's Journal. Dr. Siemens says:—

"Amongst the means at our disposal for effecting the fusion of highly refractory metals, and other substances, none has been more fully recognised than the oxy-hydrogen blast. The ingenious modification of the same by M. H. Ste.-Claire Deville, known as the Deville furnace, has been developed and applied for the fusion of platinum in considerable quantities by Mr. George Matthey, F.R.S.

"The Regenerative Gas Furnace furnishes, however, another means of attaining extremely high degrees of heat, and this furnace is now largely used in the arts—among other purposes, for the production of mild steel. By the application of the open hearth process, 10 to 15 tons of malleable iron, containing only traces of carbon or other substances alloyed with it, may be seen in a perfectly fluid condition upon the open hearth of the furnace, at a temperature probably not inferior to the melting-point of platinum. It may be here remarked that the only building material capable of resisting such heats is a brick composed of 98·5 per cent of silica, and only 1·5 per cent of alumina, iron, and lime, to bind the silica together.

"In the Deville furnace an extreme degree of heat is attained by the union of pure oxygen with a rich gaseous fuel under the influence of a blast, whereas in the Siemens furnace it is due to slow combustion of a poor gas, potentiated, so to speak, by a process of accumulation through heat stores or regenerators.

"The temperature attainable in both furnaces is limited by the point of complete dissociation of carbonic acid and aqueous vapour, which, according to Ste.-Claire Deville and Bunsen, may be estimated at from 2500° to 2800° C. But long before this extreme point has been reached, combustion becomes so sluggish that the losses of heat by radiation balance the production by combustion, and thus prevent further increase of temperature.

"It is to the electric arc, therefore, that we must look for the attainment of a temperature exceeding the point of dissociation of products of combustion, and indeed evidence is not wanting to prove the early application of the electric arc to produce effects due to extreme elevation of temperature. As early as the year 1807, Sir Humphry Davy succeeded in decomposing potash by means of an electric current from a Wollaston battery of 400 elements; and in 1810 the same philosopher surprised the members of the Royal Institution by the brilliancy of the electric arc produced between carbon points through the same agency.

"Magneto-electric and dynamo-electric currents enable us to produce the electric arc more readily and economically than was the case at the time of Sir Humphry Davy, and this comparatively new method has been taken advantage of by Messrs. Huggins, Lockyer, and other physicists, to advance astronomical and chemical research with the aid of spectrum analysis. Professor Dewar quite recently, in experimenting with the dynamo-electric current, has shown that in his lime tube or crucible several of the metals assume the gaseous condition, as demonstrated by the reversal of the lines in his spectrum, thus proving that the temperature attained was not much inferior to that of the sun.

"My present object is to show that the electric arc is not only capable of producing a very high temperature within a focus or extremely contracted space, but also such larger effects, with comparatively moderate expenditure of energy, as will render it useful in the arts for fusing platinum, iridium, steel, or iron, or for effecting such reactions or decompositions as require for their accomplishment an intense degree of heat, coupled with freedom from such disturbing influences as are inseparable from a furnace worked by the combustion of carbonaceous material.

"The apparatus which I employ consists of an ordinary crucible of plumbago or other highly refractory material, placed in a metallic jacket or outer casing, the intervening space being filled up with pounded charcoal or other bad conductor of heat. A hole is pierced through the bottom of the crucible for the admission of a rod of iron, platinum, or dense carbon, such as is used in electric illumination. The cover of the crucible is also pierced for the reception of the negative electrode, by preference a cylinder of compressed carbon of comparatively large dimensions. At one end of a beam supported at its centre is suspended the negative electrode by means of a strip of copper, or other good conductor of electricity, the other end of the beam being attached to a hollow cylinder of soft iron free to move vertically within a solenoid coil of wire, presenting a total resistance of about 50 units or ohms. By means of a sliding weight the preponderance of the beam in the direction of the solenoid can be varied so as to balance the magnetic force with which the hollow iron cylinder is drawn into the coil. One end of the solenoid coil is connected with the positive, and the other with the negative pole of the electric arc, and, being a coil of high resistance, its attractive force on the iron cylinder is proportional to the electromotive force between the two electrodes, or, in other words, to the electrical resistance of the arc itself.

"The resistance of the arc was determined and fixed at will within the limits of the source of power, by sliding the weight upon the beam. If the resistance of the arc should increase from any cause, the current passing through the solenoid would gain in strength, and the magnetic force, overcoming the counteracting weight, would cause the negative electrode to descend deeper into the crucible; whereas, if the resistance of the arc should fall below the desired limit, the weight would drive back the iron cylinder within the coils, and the length of the arc would increase, until the balance between the forces engaged had been re-established.

"The automatic adjustment of the arc is of great importance to the attainment of advantageous results in the process of electric fusion; without it the resistance of the arc would rapidly diminish with increase of temperature of the heated atmosphere within the crucible, and heat would be developed in the dynamo-electric machine to the prejudice of the electric furnace. The sudden sinking or change in electrical resistance of the material undergoing fusion would, on the other hand, cause sudden increase in the resistance of the arc, with a likelihood of its extinction, if such self-adjusting action did not take place.

"Another important element of success in electric fusion consists in constituting the material to be fused the positive pole of the electric arc. It is well known that it is at the positive pole that the heat is principally developed, and fusion of the material constituting the positive pole takes place even before the crucible itself is heated up to the same degree. This principle of action is of course applicable only to the melting of metals and other electrical conductors, such as metallic oxides, which constitute the materials generally operated upon in metallurgical processes. In operating upon non-conductive earth or upon gases, it becomes necessary to provide a non-destructible positive pole, such as platinum or iridium, which may, however, undergo fusion, and form a little pool at the bottom of the crucible.

"In this electrical furnace some time, of course, is occupied to bring the temperature of the crucible itself up to a considerable degree, but it is surprising how rapidly an accumulation of heat takes place. In working with the modified medium-sized dynamo-machine, capable of producing 36 webers of current with an expenditure of 4 horse-power, and which, if used for illuminating purposes,

produces a light equal to 6000 candles, I find that a crucible of about 20 centimetres in depth, immersed in a non-conductive material, is raised up to a white heat in less than a quarter of an hour, and the fusion of 1 kilo. of steel is effected within, say, another quarter of an hour, successive fusions being made in somewhat diminishing intervals of time. It is quite feasible to carry on this process upon a still larger scale by increasing the power of the dynamo-electric machine and the size of the crucibles.

"By the use of a pole of dense carbon, the otherwise purely chemical reaction intended to be carried into effect may be interfered with through the detachment of particles of carbon from the same; and although the consumption of the negative pole in a neutral atmosphere is exceedingly slow, it may become necessary to substitute for the same a negative pole so constituted as not to yield any substance to the arc. I have used for this purpose (as also in the construction of electric lamps) a water pole, or tube of copper, through which a cooling current of water is made to circulate. It consists simply of a stout copper cylinder closed at the lower end, having an inner tube penetrating to near the bottom for the passage of a current of water into the cylinder, which water enters and is discharged by means of flexible india-rubber tubing. This tubing being of non-conductive material, and of small sectional area, the escape of current from the pole to the reservoir is so slight that it may be entirely neglected. On the other hand, some loss of heat is incurred through conduction in the use of the water pole, but this loss diminishes with the increasing heat of the furnace, inasmuch as the arc becomes longer, and the pole is retired more and more into the crucible cover.

"To melt a gram of steel in the electric furnace takes, it is calculated, 8100 heat units, which is within a fraction the heat actually contained in a gram of pure carbon. It results from this calculation that, through the use of the dynamo-electric machine, worked by a steam engine, when considered theoretically, 1 lb. of coal is capable of melting nearly 1 lb. of mild steel. To melt a ton of steel in crucibles in the ordinary air furnace used at Sheffield, from 2½ to 3 tons of best Durham coke are consumed; the same effect is produced with 1 ton of coal when the crucibles are heated in the Regenerative Gas Furnace, whilst to produce mild steel in large masses on the open hearth of this furnace, 12 cwts. of coal suffice to produce 1 ton of steel. The electric furnace may be therefore considered as being more economical than the ordinary air furnace, and would, barring some incidental losses not included in the calculation, be as regards economy of fuel nearly equal to the Regenerative Gas Furnace.

"It has, however, the following advantages in its favour:—1st. That the degree of temperature attainable is theoretically unlimited. 2nd. That fusion is effected in a perfectly neutral atmosphere. 3rd. That the operation can be carried on in a laboratory without much preparation, and under the eye of the operator. 4th. That the limit of heat practically attainable with the use of ordinary refractory materials is very high, because in the electric furnace the fusing material is at a higher temperature than the crucible, whereas in ordinary fusion the temperature of the crucible exceeds that of the material fused within it.

"Without wishing to pretend that the electric furnace here represented is in a condition to supersede other furnaces for ordinary purposes, the advantages above indicated will make it a useful agent, I believe, for carrying on chemical reactions of various kinds at temperatures and under conditions which it has hitherto been impossible to secure."

I must explain that I am not able to bring such a current to bear as will show fully the efficiency of the instrument. In a letter received from Dr. Siemens, he says:—

"When I used the furnace at the Society of Telegraph Engineers there were two dynamo-machines giving a current of 70 webers employed, and the fusion took place in thirteen minutes in a cold crucible; the second fusion on that occasion took only eight minutes.

"Yesterday I employed one machine having a current of 35 webers, the machine being wound by the method lately brought by me before the Royal Society, and I obtained complete fusion in twenty minutes, which I considered an excellent result.

"I do not know what current you have available to experiment with, but you will not succeed in obtaining any telling result unless you employ a machine giving at least 50 webers per second."

I have not anything like 50 webers of current per second, and therefore shall not obtain the telling result which Dr. Siemens speaks of. I will turn out the crucible now, and you will see that even with our comparatively small current, and in spite of the very short time during which it has acted, the pieces of hard steel which we put in are semi-fused and agglutinated together.

In connection with electric lighting the question of the storage of electricity is becoming of importance. M. Planté's secondary battery was the first apparatus in which this storage was attempted. It consists of two lead plates placed face to face, rolled up with a small space separating them, and immersed in dilute sulphuric acid On connecting them with the terminals of a galvanic battery or a dynamo-electric machine, the plate in connection with the positive pole becomes superficially peroxidised, while hydrogen is given off from the other plate. After being thus "charged," the cell retains the charge for a long while, and we can at any time obtain a current from it. By increasing the surface of the active lead plate, and substituting zinc for the other one, as has been done in the cells on the table, we obtain a current more intense and longer in duration than in the ordinary Planté cell. As you see, the battery keeps this platinum wire red-hot for a very considerable time. These cells were charged this morning, but not to the full extent of which they are capable, and they have doubtless lost much of their original charge by accidental contacts between the plates during transport; still the effect is very considerable. The secondary battery, however, is yet far from being all that it might be, and I would recommend it to the younger chemists of the Society as a promising subject of study.

I will now turn the current on to eighteen of my lamps which we have suspended overhead, and to this one on the table, and we will turn down the gas. You see what a very much whiter and pleasanter light it is than gas-light. In Mr. Preece's letter in to day's *Times*, before spoken of, he refers to the proposed use of electricity for the illumination of coal mines, and remarks that the popular idea that this would be a mode of illumination absolutely without danger is an error. He points out that there is a serious risk of accident by fire in case of disarrangement of the wires. Of course I need not tell chemists that, in the case either of a lamp breaking or of the wires accidentally coming in contact, there would, if the accident happened in a gas-laden atmosphere, be danger of explosion. But here again I think Mr. Preece rather exaggerates the danger. It is well not to ignore the difficulties which stand in the way of the application of the light to coal-mine ilumination; but, on the other hand, it is well not to be too easily deterred by the aspect of these difficulties from examining them with a view of seeing whether they cannot be overcome.

Before I close I should just like to direct your attention to this little instrument. It is Siemens's Electro-Dynamometer, and is at present measuring the current going through our lamps. It tells me that 19 webers per second are going through it, and, as we have altogether nineteen lamps, you see that it is a weber per second for each lamp.

I have now said everything that I purposed saying to you to-night. I must apologise for the somewhat informal way in which it has been delivered; but the fact is that

my time has been so much occupied of late that I really had not leisure to prepare a more elaborate address, and judged it best to give you as good a substitute as I could. I must ask your indulgence if it has been a little incoherent.

Mr. Glover—I rise to propose a vote of thanks to Mr. Swan for his very able exposition of the present condition of electrical science as applied to useful purposes. The other night we heard—most of us—his lecture on electric lighting: to night we have gained an insight into what has been done in other directions with electricity. It has always been the dream of the chemist that a time would come when the so-called imponderable forces would become the active agents in our every-day life; it now seems as though that dream would be realised. It has been reserved for Mr. Swan to bring electric lighting into a position in which it promises to be a complete success. It may be said to be now with electric lighting as it was with gas lighting when Murdoch, in 1798, lit up the workshop of Boulton and Watt, and Winsor, in 1803, illuminated the Lyceum Theatre with gas. Since then we have seen the wonderful development of gas lighting. At that time all kinds of evils were predicted if gas should be brought into our houses. We were to be suffocated, blown up, poisoned: in fact, so dense was the ignorance, as we should now call it, of people in those days with regard to gas, that Acts of Parliament compelled Gas Companies to surround their gasometers with enormously strong walls, as such a mass of explosive material would be extremely dangerous. Even Sir Humphry Davy, when shown a large gasometer in the neighbourhood of London, said it was extremely dangerous, and could hardly be persuaded to stand by while the engineer struck a nail into the gas-holder and lighted the issuing gas. I mention these facts to show that the objections to electric lighting stated by Mr. Preece and others may be safely left to be dealt with by scientific men. The electric light must now go on, and that state of things is largely due to Mr. Swan. I should like to see a portion of our town lighted with the beautiful light which is so soft and yet so brilliant, and does not pollute the air with any noxious vapours.

Mr. Clapham—I have much pleasure in seconding the vote of thanks to Mr. Swan. Mr. Glover has spoken of lighting with gas. It may perhaps interest some members to know that my father was the first in this town to light up his premises with gas, made specially by a small apparatus on the premises, and it is a curious circumstance that the very shop in Pilgrim Street which he then occupied is now in the possession of Mr. Swan, who will no doubt soon light it up with electricity.

PHILOSOPHICAL SOCIETY OF GLASGOW.

Chemical Section.

Mr. J. Mactear, F.C.S., F.I.C., President, in the Chair.

The opening meeting of this Section for the session 1880-81 was held in the Society's rooms on Monday, November 8. Fifteen gentlemen were proposed as Associates of the Section.

The President delivered a short opening address. He apologised for being unable, through pressure of business, to read the paper which he had promised on "The History and Technology of Sulphuric Acid," but expressed the hope that he would be able to read it before the end of the session. He congratulated the Society upon having obtained, this session, rooms of their own in which to meet. He pointed out the advantages which the Section offered to young chemists, and urged the Associates to do all in their power to promote the prosperity of the Section by taking an active part in its work, and by endeavouring to induce their friends to join it. He then sketched the past history of the Section. As early as 1840 a Chemical Section of the Philosophical Society existed, whose chief function it was to provide papers on chemical, geological, and mineralogical subjects to be read before the Society. Dr. Stenhouse, Prof. Thomson, Dr. And. Buchanan, Mr. John Tennant, Mr. Walter Crum, and Dr. J. H. Robertson were amongst the gentlemen upon the committee of the Section at that time. Since the constitution of the Section in its present form in 1868 a large number of valuable papers, many of them upon technical subjects connected with the chemical industries of the city, had been read before it. Mr. Mactear concluded by reading a list of the papers, and made remarks upon those of special interest.

Mr. J. E. Stoddart then read a paper on the "*Desilverisation of Lead by the Zinc Process*," as carried on at the Clyde Lead Works, Glasgow. He said:—

The treatment of argentiferous leads with zinc, for the purpose of extracting the silver and refining the lead, is by no means a novel process. About twenty years ago a metallurgist named Parks took out patents for desilverising rich leads by means of zinc, and a manufacturing firm adopted his process. They were, however, subsequently obliged to abandon it, in consequence of the difficulty experienced in the separation of the zinc from the concentrated silver, to admit of the cupellation of the latter metal. A German chemist named Flach afterwards took up the subject, and by running the alloy of zinc, silver, and lead, along with iron slag, through a peculiarly constructed blast-furnace, was enabled to free the concentrated silver-lead from zinc. He also proposed the use of this furnace for removing of traces of zinc from the desilverised lead, but this was abandoned in favour of the ordinary improving or calcining pan. The operation with the blast-furnace was found to be very troublesome, and as the greater portion of the zinc was entirely lost, was by no means economical. M. Manes, of Messrs. Guillem & Co., Marseilles, who were the first to work Flach's process, found out and patented a simple means of treating the alloy, and recovering the zinc by distillation. This is the process now in use and known as the Flach-Guillem process, and which is carried on in the following manner:—About 18 tons of "rich lead," containing generally from 60 to 70 ounces of silver per ton, are melted in a large cast-iron pot, to which 1 per cent by weight of zinc is added, and the whole well stirred for twenty minutes. The fires are drawn, and the contents allowed to settle and cool until the zinc rises to the surface, and forms a solid ring or crust containing the silver and other foreign metals. This alloy is removed to a small pot at hand, where part of the lead is sweated out, and the alloy thoroughly dried. The large pot with the lead now partially desilverised is again heated up, and treated in the same way as before, but with the addition of only a half per cent of zinc, which when it has risen to the top is removed as before, and dried. A third addition of a quarter of per cent of zinc is found necessary to take out the remainder of the silver, care being taken, on the cooling of this zincing, that all the crystals are cleanly skimmed off. The lead in the large pot is assayed, and found almost always to contain less than 5 dwts. of silver to the ton of lead: if it should happen to contain more, it is due to carelessness on the part of the workmen. The pot is now tapped, and the lead run down into an improving pan, where it is kept at a high heat for nearly eight hours, for the purpose of oxidising or burning off the small percentage of zinc which is left in it from the zincing process: after seven or eight hours' firing in this pan it should contain no trace of zinc. It is then tapped and run into moulds for market lead, or for the manufacture of lead products. The old improving pans were made of cast-iron, placed on a bed of sand, with a groove in the upper sides, which groove was filled with bone-ash to prevent the action of oxide of lead on the iron. These pans, from the giving way of the bone-ash, and the great wear and tear on the iron from the high heats necessary, were found to be both troublesome

and expensive; they were very often under repair, and seldom lasted more than six or eight months. They have been superseded by an improving pan of cast-iron lined with brick inside. This pan, instead of being placed on a bed of sand, as was the case with the old improving pan, is hung on brick walls, and is quite open both below and round the outside. This new pan has been working in the patentee's works, Marseilles, for some years without any break down. It burns no more coal, and can be as economically worked in every way as the old pans. The zinc and silver alloy, after being dried, is melted in a plumbago crucible, covered on the top, well luted with fire-clay, connected with a small cast-iron receiver by means of a plumbago pipe, and fired up with coke. The zinc distils over, and is condensed in the iron receiver. After all the zinc has been distilled, the pipe is disconnected, the cover removed, and the lead and silver left in the crucible is ladled out into moulds. Thence it is taken to the refinery, where it is cupelled in the usual way. The block of metallic zinc recovered in the condenser is removed, and used over again in the first part of the process. All the oxide of lead and dross formed in the different processes are taken to the reducing-furnace, mixed with coal-dross, and reduced back to the metallic state. The refuse from this furnace still contains some lead, and is put through the slag hearth, a blast-furnace fired with coke, the fumes of lead oxide from which are condensed in what is known as Johnson's patent condenser, and are all recovered. The lead from the slag hearth, containing a number of impurities, as copper, antimony, iron, or sulphur, is taken to the improving furnace—a furnace built in exactly the same way as the dezincifying pan. About 20 tons of this lead are heated for a period generally from four to five days, but the time varies according to the amount of impurities present. The oxidised impurities, as they are formed, float to the surface, and are skimmed off by the workman, who is made to keep the lead perfectly clean, so as to have a fresh surface always exposed to the action of the flame. The dross skimmed off is at first of a black colour, but gradually becomes lighter as the operation goes on, until it shows nothing but yellow oxide of lead. When this appearance is noted the pan is tapped into moulds, or into the desilverising pot, where it is treated with zinc, and the silver extracted as in the manner before described. By this process the lead can be desilverised and turned out in the shape of market lead in thirty hours from the time it is put in process; the loss in working being not more than 1¼ per cent, and the amount of oxide of lead formed is very much less than that formed in any of the other processes, thereby effecting a very considerable saving in the working expenses. It makes an excellent quality of sheets, pipes, red-lead, and litharge, and has even been used for the manufacture of white-lead. There is, however, one product it cannot be used for by itself, and that is the manufacture of chemical lead. Your President gave us a very interesting paper on this subject last session, showing that the reason of its not being suitable for this was on account of its extreme purity. I understand that Mr. James Napier, jun., of this Society, has done a number of experiments in the same direction, and found that by adding to it a small percentage of copper or antimony, or both, a good chemical lead can be obtained. That all the silver is thoroughly taken out may be seen from the fact that there is an excess of silver obtained on the large scale to the extent of nearly 2 per cent over the assays. An analysis of the market lead gave—Antimony, 0·0015, and silver 0·0004 per cent, a trace of copper, but no iron or zinc; from which it will be seen that the lead refined by the zinc process is almost chemically pure, and to this is due the finer quality of the products manufactured from it.

A short discussion, chiefly on the durability of various qualities of lead, followed the reading of Mr. Stoddart's paper, and it was arranged to have a special discussion of the subject at the next meeting of the Section.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
No. 12, 1880.

Chemical Stability of Matter in Sonorous Vibration.—M. Berthelot.—Already noticed.

The Density of the Vapour of Iodine.—MM. J. M. Crafts and F. Meir.—This paper cannot be reproduced without the accompanying woodcut.

Preparation of Ashes Destined for the Extraction of Iodine from Sea-weeds.—Dr. Thiercelin.—The most advantageous weeds for this purpose are the two varieties of *Fucus digitatus*. The author states that he has succeeded in extracting from the plant 3 per cent of iodine.

Manufacture of Phosphoric Acid.—M. A. Colson.—Natural phosphates, unground, are dissolved in dilute hydrochloric acid. When the acid has ceased to act the clear solution is run off from the insoluble matters and mixed with sulphuric acid enough to saturate all the dissolved lime, leaving a mixture of hydrochloric acid, dilute phosphoric acid, and calcium sulphate. This mixture is submitted to pressure to separate the sulphate from the free acids, which are then concentrated, and the hydrochloric acid is condensed and collected for use by means of ordinary columns.

Complex Acids Containing Boric Acid.—Dr. F. Mauri.—The author has formed boro-tungstic acid by dissolving tungstic anhydride in a solution of borax, and continuing to add the former until the liquid is no longer rendered turbid by hydrochloric acid. He is engaged with the formation and the study of the boro-molybdic acid and its salts.

Compound of Titanium Tetra-chloride and of Phosphorus Proto-chloride.—M. Armand Bertrand.—The composition of this compound is represented by the formula $TiCl_4PCl_3$.

Compound of Titanium Tetra-chloride and Ethyl Oxide.—M. Armand Bertrand.—If the vapours of these two bodies are brought in contact, fine crystals of a greenish yellow colour are produced.

Reduction of Ethyl Nitrate by Alcohol.—M. Armand Bertrand.—Nascent ethyl nitrate is reduced in presence of alcohol, yielding ethyl nitrite and aldehyde.

Products Contained in the Coke of Petroleum.—MM. L. Prunier and Eug. Vareune.—In the experiments of the authors, the accumulation of the carbon is effected with an increasing rapidity, and the weight of the molecule rises to a limit still little known, but which can be no other than the formation of insoluble bodies whose richness in carbon is equal or even inferior to that of the bodies which have remained soluble. We reach thus, by a progression easy to conceive, the term of the series which must equally include crystalline bodies such as graphite and diamond. It is known, on the other hand, that the higher polymers, when submitted to very high temperatures, seem to depolymerise themselves (as happens with meta-styrolene), yielding gaseous carbon compounds.

Preparation of Malonic Acid.—M. E. Bourgoin.—Already noticed.

On Tetric and Oxytetric Acids and on their Homologues (Continued).—M. Eug. Demarçay.—Already noticed.

Formation Heat of Gun-Cotton.—MM. Sarrau and Vieille.—The gun-cotton in question was a commercial sample—a mixture of bi- and trinitro-cellulose. The au-

thors give as the formation heat 542 calories per kilo., or 620 per equivalent.

Isomers of Phloro-glucin.—M. Arm. Gautier.—The bodies examined are œno-glucin, querci-glucin, and pheno-glucin.

Action of Mono-bromated Diphenyl-methan upon Ammonia.—MM. C. Friedel and M. Balsohn.—If the ammonia is in alcoholic solution, ammonium hydrobromate is deposited; and the alcoholic liquid, if precipitated with water, yields, as a principal product, a mixed ethyl-benzhydrolic ether. Concentrated aqueous ammonia acts differently; the crystalline bromine is gradually transformed, and in twenty-four hours the mass becomes liquid. In forty-eight hours more it becomes solid, and then it no longer contains bromated diphenyl-methan.

New Synthesis of Diphenyl-Acetic Acid.—MM. C. Friedel and M. Balsohn.—Already noticed.

Correspondenz-Blatt des Vereines Analytischer Chemiker. No. 15.

Colorimetric Determination of Chlorine in Potassium Bromide.—C. Roth.—One grm. potassium bromide is ground to a powder with an approximately equal quantity of potassium bichromate, placed in a flask holding 100 c.c. and covered with 5 c.c. concentrated sulphuric acid. The flask is then connected air-tight, by means of an adaptor ground to fit its mouth, with a receiver containing 100 c.c. very dilute ammonia (5 or 6 drops of caustic ammonia to 100 c.c. of water). A gentle heat is applied and raised to about 128°. There should be two large bulbs blown on the connection tube to prevent the reflux of the liquid. When all the chlorine has thus been expelled, the distillate is compared with solutions of ammonium chromate of known strength prepared for the purpose.

Les Mondes, Revue Hebdomadaire des Sciences. No. 8, July 15, 1880.

New Dielectric Machine.—M. Le Dantec.—An illustrated paper, which does not admit of reproduction.

MISCELLANEOUS.

The Royal Society.—The following is the list of Officers and Council for the ensuing year:—

President—William Spottiswoode, M.A., D.C.L., LL.D.

Treasurer—John Evans, D.C.L., LL.D.

Secretaries—Prof. George Gabriel Stokes, M.A., D.C.L., LL.D.; Prof. Thomas Henry Huxley, LL.D.

Foreign Secretary—Prof. Alexander William Williamson, Ph.D.

Other Members of the Council—William Henry Barlow, Pres. Inst. C.E.; Rev. Prof. Thomas George Bonney, M.A., Sec. G.S.; George Busk, F.L.S.; Right Hon. Sir Richard Assheton Cross, G.C.B.; Edwin Dunkin, V.-P. R.A.S.; Alexander John Ellis, B.A.; Thomas Archer Hirst, Ph.D.; William Huggins, D.C.L., LL.D.; Prof. John Marshall, F.R.C.S.; Prof. Daniel Oliver, F.L.S.; Prof. Alfred Newton, M.A., Pres. C.P.S.; Prof. William Odling, M.B., V.-P. C.S.; Henry Tibbats Stainton, F.G.S.; Sir James Paget, Bart., D.C.L.; William Henry Perkin, Sec. C.S.; Lieut.-Gen. Richard Strachey, R.E., C.S.I.

TO CORRESPONDENTS.

A. E. S.—The iridescence on ancient glass is supposed to be due to the removal of alkali from the surface by long-continued weathering. A film of silica is left on the surface, which shows the colours of thin plates.

Errata.—Page 261, col. 1, line 9 from top, *for* 13·2 *read* 13·8. Page 263, col. 1, line 24 from bottom, *for* ekaluminium-gallium *read* ekaluminium or gallium, *and for* equabor-scandium *read* ekabor or scandium.

NOTES AND QUERIES.

"The Nature of Nitre."—I picked up the other day, from a pile of old books, a curious little book, evidently very old, the title-page of which is unfortunately missing, but which is otherwise complete. It treats—"Of the Name and Nature of Nitre," under the following headings:—"The Peripatetical Definition of Nitre," "Of the Generation and Place of Nitre," "That Nitre is a general cause of Meteors," "That Nitre is a material cause of Lightning and Thunder," "That the Fiery Rain of Brimstone and Fire on Sodom and Gomorrah was Lightning, and that Nitre is expressed by the word Fire," "The Use of Nitre in the Great and Noble Art of Artillery," "The Use of Nitre in Chymistry," &c. Could you kindly inform me, in your "Notes and Queries," as to the age and author of this little book?—W. W. S.

MEETINGS FOR THE WEEK.

Monday, 6th.—Medical, 8.30.
—— London Institution, 5.
—— Society of Arts, 8. "Some Points of Contact between the Scientific and Artistic Aspects of Pottery and Porcelain," by A. H. Church, F.C.S.
—— Royal Institution, 5. General Monthly Meeting.
Tuesday, 7th.—Civil Engineers, 8.
Wednesday, 8th.—Society of Arts, 8. "London Fogs," by Dr. Alfred Carpenter.
—— Microscopical, 8.
Thursday, 9th.—Royal, 4.30.
—— Royal Society Club, 6.30.
—— Mathematical, 8.
—— London Institution, 7.
Friday, 10th.—Astronomical, 8.
—— Quekett, 8.
—— Clinical, 8.30.
Saturday, 11th.—Physical, 3. "On the rate of Loss of Light from Phosporescent Surfaces," by Lieut. L. Darwin, R.E. "On the Determination of Chemical Affinity in Terms of Electromotive Force," by Dr. Alder Wright.

Wanted, to Purchase Volumes 1, 3, 5, 6, and 7, of the "Journal of the Chemical Society"; also Vol. 3 of the "Proceedings of the Royal Society."—Address, K. P. G., Chemical News Office, Boy Court, Ludgate Hill, London, E.C.

MR. J. S. MERRY,
ASSAYER AND ANALYTICAL CHEMIST,
SWANSEA.

MOTTERSHEAD & CO.,
7, Exchange Street and 10, Half Moon Street,
MANCHESTER.
CHEMICAL & PHYSICAL APPARATUS,
BOTTLES, PURE CHEMICALS,
REAGENTS, STANDARD SOLUTIONS,
And Every Requirement for Works' or School Laboratories or Private Students.
Illustrated Price Lists on application.

THE CHEMICAL NEWS
AND
JOURNAL OF PHYSICAL SCIENCE.
Edited by WILLIAM CROOKES, F.R.S.
Published every Friday. Price 4d. Annual Subscription, post free including Indices, £1

CHARGES FOR ADVERTISEMENTS.

	£	s.	a.
Five lines in column (about 10 words to line)	0	3	6
Each additional line	0	0	6
Whole column	1	15	0
Whole page	3	0	0

A reduction made for a series of insertions.
Cheques and Post-Office Orders, crossed "London and County Bank," payable to the order of William Crookes.
BOY COURT, LUDGATE HILL LONDON, E.C.

GREENBANK ALKALI WORKS COMPANY (LIMITED), ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{3}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{1}{200}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

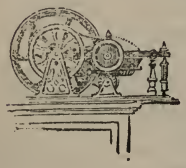
CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

Carr's Patent Paint and Drug Mill.

Approved by some of the most eminent Chemists, and awarded the Silver Prize Medals of the Manchester and Liverpool, and the Middleton Agricultural Shows.



From Messrs. E. H. Smyth & Co., 21, Duke Street, Edinburgh, and 69, Coleman Street, City, London.—The small Levigator Mill we recently got from you works most efficiently, and is a great economiser of time.

The chief feature in this machine is, that although it can be turned with ease by a boy, it has immense frictional power for levigating purposes. This is caused by the runner being driven at a much greater speed, but in the same direction, than the bowl. The surfaces being Minton ware, they are clean, smooth, and durable.

Testimonials on application.

£11 nett cash, delivered in Manchester.

The diameter of the bowl is 18 ins., and it and the runners are made of Minton ware. It is useful for Painters, Chemists, Grocers, and Cooks, for triturating and mixing Medicines, Vegetable Powders, Ointments, Paints, Sugar, Salt, Spices, Herbs, Meat for Potting, and will grind the coarsest Emery into a nearly Impalpable Powder in a few seconds. The pan can be tilted for emptying, as shown in the dotted lines; it can be worked by hand or power.

SOLE MAKERS—
W. H. BAILEY & Co., Albion Works, Salford, Manchester.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
SULPHITE OF SODA. TANNATE OF SODA.

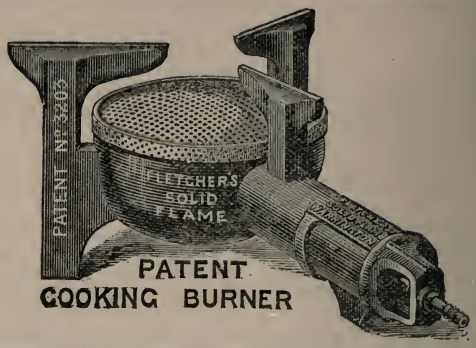
WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

FLETCHER'S
PERFECTED SOLID FLAME GAS COOKING AND HEATING BURNER.

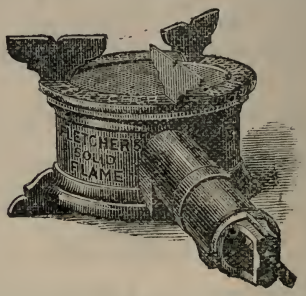
PATENTED AUGUST, 1880.

The only perfect Burner for Cooking, Boiling, and Dirty Laboratory Work. Free from smell, the most powerful Burner known, and not damaged by the roughest, dirtiest work. This Burner is a valuable improvement on Fletcher's well-known Solid Flame Burner, of which



thousands are in daily use. The Gauze is done away with and replaced by a loose perforated Dome of Solid Copper, which can be taken off and cleaned when choked with dirt. The Stand is broad and firm, supporting large or small vessels safely and steadily.

PRICE, Japanned, 6s. 6d.; Nickel Plated, 8s. 6d



ORIGINAL SOLID FLAME BURNER, with Gauze, Price, Bronzed, 4s.; Nickel Plated, 5s.

All these Burners are the same power, and will with equal ease Boil an Egg, Cook a Chop, Boil a Kettle, or Melt half a hundredweight of Lead in an Iron Pot. They will Boil half a gallon of Water in a Flat Copper Kettle in Six Minutes, and work equally well with Air Gas or Coal Gas.

Complete Illustrated List, Price 3d., of Gas Furnaces for Crucibles, Muffles, Ladles, Porcelain, Painting, &c.; Hot and Cold, Blast Blowpipes; Foot, Hand, and Automatic Blowers, Ingots Moulds, &c.; with reprint of Mr. Fletcher's Lecture to the Society of Arts on *The Application of Gaseous Fuel to Laboratory Work*, for which he was awarded the Society's Silver Medal in June, 1880.

THOS. FLETCHER,
4 & 6 MUSEUM STREET, WARRINGTON.

BISULPHIDE OF CARBON.
CHLORIDE OF SULPHUR.

GAS PURIFICATION & CHEMICAL CO., LIMITED,
161, 162, 163, Palmerston Buildings, London, E.C.

THOMAS ADKINS & CO.,
SMETHWICK,
NEAR BIRMINGHAM.

Manufacturers of Specially Prepared Red Lead for Flint-Glass Making.

THE CHEMICAL NEWS.

VOL. XLII. No. 1098.

THE ESTIMATION OF CHROMIUM IN IRON AND STEEL.

By J. OLIVER ARNOLD, F.C.S.

THIS subject has received comparatively little attention from iron and steel chemists, and, as far as I know, no satisfactory method has yet been published. The method in general use is volumetric and indirect. The steel is dissolved in dilute H_2SO_4, the $Cr_2(SO_4)_3$ thus formed is oxidised to H_2CrO_4 by means of $KMnO_4$. The solution is filtered, acidified, and a known weight (in excess) of $FeSO_4$ is added. The excess is determined by a standard solution of $K_2Cr_2O_7$. The difference between the original amount and the excess is the amount of Fe converted from the dyad to the tetrad condition by the chromic acid. From this the Cr is estimated; every 3 equivs. Fe represent 1 equiv. Cr.

This method I find to be most unsatisfactory. In the first place, the results depend upon a ferrous solution, liable at any moment to accidental oxidation, and from this cause alone, when experimenting with steels into which a known amount of Cr had been introduced, I have observed errors ranging from 0·05 to 0·2 per cent. But in the actual alloy a constant cause of error arises from the fact that chrome-steel is not completely soluble in dilute H_2SO_4, even after long-continued boiling. A black residue remains, consisting of Fe, Mn, and Cr. If this residue is thoroughly washed with hot water, dried, and fused with Na_2CO_3, the mass dissolved out with hot water, a drop of alcohol added, and the solution filtered, the yellow colour of the chromate will be seen; it may be reduced with HCl, ammonia added, and a distinct precipitate of $Cr_2(HO)_6$ obtained. In the case of a soft steel that cannot be crushed to a fine powder, the error becomes most serious. I would therefore propose the following direct and gravimetric method:—

Weigh out from 1 to 5 grms. of the steel (in drillings) according to the amount of Cr present (this may be ascertained by a rough colorimetric test). Place the metal in a wide, covered beaker, and add 20 c.c. of strong HCl; heat till all action is at an end; rinse the cover and sides of the beaker from splashings, and evaporate the solution *gently* to complete dryness. If the evaporation has not been too rapid, the chlorides may be almost entirely detached from the bottom of the beaker in a brittle cake. This is broken up into small pieces by means of a platinum spatula, and as much as possible is brushed out into a clean dry porcelain dish. A small quantity of the chlorides will, however, remain adhering to the beaker; this may be removed with 2 or 3 c.c. of dilute HCl. The solution is poured into a deep platinum crucible, the beaker rinsed with 1 or 2 c.c. of water, the washings added to the crucible, the contents of which are now evaporated to dryness on a sand-bath. When dry the main quantity of the chlorides is carefully brushed out of the porcelain into the platinum dish, and is reduced to a fine powder by means of a little pestle made from glass rod. The spatula and pestle are cleaned into the crucible. The finely-divided chlorides are now thoroughly mixed with an excess of fusion mixture (1 part dry Na_2CO_3 to 1 part powdered KNO_3), a cover is placed over the crucible, and its contents are fused over a gas blowpipe till quite liquid. By this treatment the Fe is converted into insoluble oxide, the Mn, Si, and Cr respectively into alkaline manganate, silicate, and chromate. When cool the crucible is placed in a beaker containing 80 c.c. of boiling water, and is gently boiled till the fused mass is detached and dissolved out. This may be assisted by occasional stirring with a glass rod. When clear from oxide, remove the crucible and cover, washing them well with hot water. Add 3 or 4 drops of alcohol to decompose the manganate, and allow the oxides of Fe and Mn to settle thoroughly. When the supernatant liquid is quite clear it is decanted on a close double filter, the filtrate being received into a clean beaker. The precipitates are disturbed as little as possible. When all the clear liquid has passed through, the filter is well washed with hot water. The precipitates are now washed twice by decantation with 30 c.c. of hot water; at the second washing the contents of the beaker are allowed to drain *gently* into the filter, which is now allowed to drain thoroughly, and is removed without further washing. These precautions in washing must be strictly carried out, as the Fe_2O_3 is in such an exceedingly fine state of division that any attempt to wash or disturb it on the filter will inevitably cause some of it to pass through into the chromium solution. The *clear* yellow filtrate contains the Cr and Si; to it is added 20 c.c. of HCl, the cover being kept on the beaker, to prevent projection of the solution by the evolved CO_2. The solution is now well boiled until all the CO_2 and nitrous fumes are driven off. Its colour will now be green owing to reduction to chloride. Dilute AmHO is added to alkaline reaction and the solution heated nearly to boiling. The resulting precipitate consists of $Cr_2(HO)_6$,$Si(HO)_4$, mixed with alkaline salts. It is collected on a filter (previously well washed with hot dilute HCl to free it from iron), and is slightly washed. When the washings have drained through, the precipitate is dissolved off the filter with hot dilute HCl, the filtrate being received into the beaker in which the precipitation took place. The solution is now evaporated to dryness to convert the $Si(HO)_4$ into SiO_2. The soluble Cr_2Cl_6 is taken up with 10 c.c. HCl and 90 c.c. of water, and is filtered through a washed filter into a clean beaker, the filter being well washed. The precipitation is now repeated as above, and the $Cr_2(HO)_6$ comes down free from silica and alkaline salts. It is collected, washed, dried, ignited, and weighed as Cr_2O_3.

Precautions.—Only 3 or 4 drops of alcohol should be added, as this quantity is sufficient, not only to precipitate the manganese, but also to effect the reduction to chloride. If too much is added organic compounds are formed, which tend to prevent the complete precipitation of the hydrate. The ammonia in the last precipitation should be added in the least possible excess, and the solution should be heated gently *nearly* to boiling. If any great excess of ammonia be present, and if the solution is boiled, the glass of the beaker is attacked and the result is high. The method if carefully carried out is accurate, as the following analyses will show:—

Three quantities of a steel free from chromium, each weighing 1·98 grms., were taken; to each was added 0·0563 grm. $K_2Cr_2O_7$. This mixture corresponds to a steel containing 1 per cent Cr.

A gave 0·973 per cent chromium.
B „ 1·022 „ „
C „ 0·978 „ „
Mean, 0·991 per cent.

Three quantities weighing 1·99 grms. were now taken, and 0·02815 grm. pure $K_2Cr_2O_7$ was added to each. This mixture corresponds to a steel containing 0·5 per cent Cr.

A′ gave 0·511 per cent Cr.
B′ „ 0·470 „ „
C′ „ 0·508 „ „
Mean, 0·496 per cent.

The results B, A′, C′, are high, owing to boiling off excess of ammonia. I believe the error to average 0·03 per cent low, as a third series corresponding to 1 per cent Cr gave, when excess of ammonia and boiling were avoided:—

1 gave 0·966 per cent chromium.
2 „ 0·972 „ „
3 „ 0·976 „ „
Mean error, 0·029 low.

With average care the error will never exceed 0·05 per cent. A duplicate estimation can be carried out in a day and a half.

I take this opportunity of thanking Mr. J. W. King for his valuable assistance and suggestions through a long course of experiment.

Sheffield, November 23, 1880.

NOTE ON THE RUSTING OF IRON.

By Dr. T. L. PHIPSON, F.C.S.

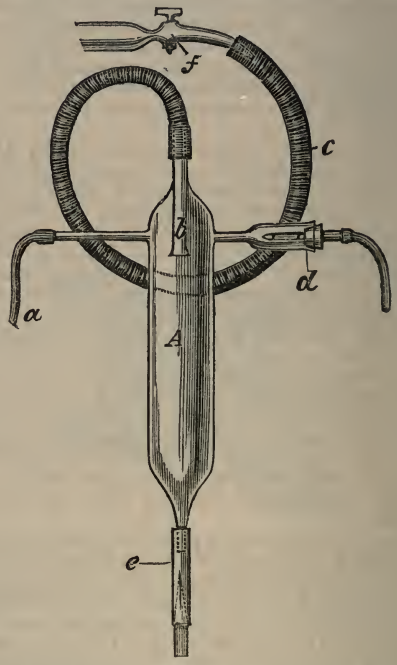
In the Chemical News, vol. xlii., p. 271, a correspondent asserts that in making some photographic experiments, he found that iron and steel do not rust when immersed in solutions of caustic soda and caustic potash, but he appears to have been unable to discover any explanation of the fact in the books and journals to which he has access. "I cannot understand," he says, "why the alkali in the solution prevents the oxygen in the water acting on the iron or steel." The fact has been known for a great many years, and the true explanation was pointed out, I believe, for the first time, by the late much-regretted Dr. Crace-Calvert, to whom modern chemistry is indebted for much useful work. Dr. Calvert's explanation is in strict accordance with the theory propounded some years previously (1858) in my paper on "Catalytic Force," often alluded to in this journal. His experiments showed that the phenomenon of the rusting of iron was due to the presence of carbonic acid, this body forming the *third substance* requisite, according to my theory of catalysis, to complete the galvanic chain. Without the presence of this carbonic acid, or some other *third substance* capable of taking its place, the oxygen cannot combine with the iron at ordinary temperatures. A high temperature acts, as we know, like electricity in promoting the combination. As long as there is free caustic alkali present, of course there can be no carbonic acid, and no rust is formed.

A NEW FORM OF FILTER PUMP.

By THOMAS BAYLEY.

There are two forms of filter pump in use in laboratories at present, the Bunsen pump and the pulse pump. Both are worked by water; the Bunsen pump requires a fall of more than 30 feet to give a fairly good vacuum, and the pulse pump can only be used with water delivered under high pressure. It must very often happen that neither a fall of 30 feet, nor a supply of water at high pressure, can be procured, and yet a filter pump may be desired. Under these circumstances the instrument figured below may be used with good effect. It consists of a glass tube A, with which four other tubes communicate, as shown. The tube *a* is connected to a flask from which steam issues at atmospheric pressure, and the tube *b* is connected to the water supply by means of a piece of caoutchouc tubing *c*, about 2 feet long. At *d* there is another tube, and between this and the central tube A is a Bunsen's valve, opening into A. At *e* there is another Bunsen's valve, opening into the external air. The action of the pump is explained thus:—The tube A being full of air a current of steam enters through *a* and expels the air through the valve *e*. The tap *f* is all the time open to such an extent that a small stream of water would flow through it; a fall in frequent drops of the steam current were absent. The steam current entering A meets the water in *b* and forces it backwards, and at the same time the caoutchouc tubing swells slightly under the influence of the pressure. During about one-third of a second the current of steam continues and the water current is arrested; then suddenly the water, which has been kept back and accumulated, enters into the space containing the steam; the latter is instantly condensed, a sharp convulsion takes place, and air is sucked through the valve D. The cycle of actions then recommences, the steam drives at the air, the inrush of water is repeated, and air again passes into A through the valve *d*.

While a pump of this kind was working satisfactorily, and producing a vacuum of 22 inches of mercury, the following observations were made:—The pulsations took place every second; through the valve *e* steam mixed with air passed for half a second, followed by hot water for the same period: the latter was delivered at a temperature of 55° or 60° C. to the extent of about 150 c.c. per minute. The pump working in this manner cannot of course yield a full vacuum, because the pressure of



aqueous vapour at a temperature of 60° C. is about 6 inches of mercury, and it is manifest that the valve *d* will not open unless the pressure in the receiver is greater than this. However, it is quite possible that in the early stage of condensation the temperature in the interior is less than the temperature at which the water is expelled, and of course a better effect may be obtained by using more water. The pump acting as described produced a considerable vacuum in a 40 oz. bottle in a few minutes.

I have used a slight modification of the Bunsen valve for this and other purposes. The arrangement is shown at *e*, the rod which closes the end of the caoutchouc tube forming the valve is drawn out and lies under the slit. This prevents the collapse and failure of the valve.

This pump could no doubt be fitted up for use either as a Bunsen pump or as a steam pump, or as the two combined. By a simple arrangement it can be made to exhaust, to blow air, and to deliver boiling water at the same time. The boiling water obtained is the water flowing from the pump *subsequently* mixed with the excess of steam. The water in the flask boils at a small fraction above the ordinary pressure, the excess being required to open the exit valve.

NOTE ON SIEMENS-MARTIN STEEL.

By SERGIUS KERN, M.E., St. Petersburg,

In most cases this steel is used for shipbuilding and boiler making. In the manufacture of plates the author has noticed that the Siemens-Martin ingots stand a better heat and roll more softly than Bessemer ingots containing the same quantity of carbon. Moreover, Siemens-Martin ingots contain, as a rule, less manganese than Bessemer ingots, and as plates containing much manganese are more liable to oxidise, the Siemens-Martin plates are preferable for the above-mentioned purposes.

The following table shows what beautiful results are obtained in testing Siemens-Martin steel. Giving a high elongation, it shows a good breaking strain, taking into consideration the percentage of carbon (0·45 to 0·60 per cent). Bessemer steel containing the same amount of carbon never gives such results. The specimens tested were intended for other purposes than plate-rolling, but by annealing, most of this steel will be quite good enough to stand Lloyd's tests.

Siemens-Martin Steel.

Length 8″; thickness §″; percentage of carbon 0·45 to 0·60.

Samples.	Breaking Strain. Tons per Sq. Inch.	Elongation. Per cent.
1.	34·49	18·40
2.	33·15	21·10
3.	35·81	20·00
4.	42·53	20·00
5.	34·49	21·90
6.	38·03	16·60
7.	43·65	19·10
8.	36·93	20·00
9.	44·29	16·10
10.	40·29	17·40
11.	40·50	23·70
12.	31·80	20·30

ANALYSIS OF FORAGE BISCUITS.

By C. J. H. WARDEN, Bengal Medical Staff, Chemical Examiner to Government.

The forage biscuits which form the subject of the following report were forwarded to the Chemical Examiners' Department by the Assistant Commissary General, Calcutta.

The biscuits were circular in shape, with a central hole, and weighed on an average 100 grms. each. A physical examination resulted in the detection of linseed, peas, and husks, not unlike those of barley. The marked indications of phosphoric acid and iron, subsequently found in the ash, also favoured the view of the presence of this cereal.

In order to obtain a sample for analysis portions of several biscuits were pulverised; 100 parts contained:—

	A.	B.	Mean.
Water	13·611	13·721	13·666
Albuminoids.. ..	15·514	15·673	15·594
Carbohydrates ..	57·525	56·380	56·953
Fibre	1·022	1·453	1·237
Fat	7·326	7·920	7·623
Ash	5·002	4·853	4·927
	100·000	100·000	100·000

Albuminoids = N×6·33. Nitrogen was estimated by Varrentrap and Will's method, a long combustion-tube being employed, and the ammonia absorbed by dilute hydrochloric acid, the chloride being weighed as the ammonic-platinic chloride. Fibre was determined by the acid and alkali process.

The ash was of a reddish colour, and contained iron, phosphoric, sulphuric, and traces of nitric and carbonic acids, together with lime, &c. Chloride of sodium was present to the extent of 0·806 per cent calculated on the biscuits, and was estimated in a portion which had been charred at a temperature below redness. The albuminoids, or nitrogenous constituents, are present to the extent of nearly 16 per cent. Grain *Cicer arietinum*, on which horses are largely fed in India, contains 22·7 per cent, peas 23 to 28 per cent, and barley and oats 12·9 and 14·3 per cent respectively. The nitrogenous principles are, therefore, fairly represented.

Fat is present in rather larger amount than is usual in the diet of horses. Grain, barley, and oats contain 3·7, 2·7, and 5·5 per cent respectively. It is possible that an excess of fat in the food might disagree after a time; but this is a point which can only be decided after actual experiment.

The linseed was probably in the form of meal, after removal of most of the oil, and was most likely added as a material with which to agglutinate the other ingredients, and so admit of a finer biscuit being manufactured. At the same time linseed is nutritious and assists in the formation of fat and muscle.

I have recently, through the courtesy of Messrs. Lord and Co., Calcutta, been furnished with a copy of the extract of the proceedings of a Committee assembled at Meerat in June last, to report on these biscuits. Nine horses were selected for experiment, all country-breds, of nearly similar shape, size, and condition, and all subjected to the same treatment as regards work. They were watered three times a day before each feed; none of them had any bedding.

Lot 1. Consisting of three horses, were fed on 4 seers grain and about 15 seers grass daily.

Lot 2. Three horses were fed on 3 lbs. biscuits and about 15 seers of grass.

Lot 3. Three horses were fed on 6 lbs. of biscuits only, no grass being allowed.

The experiments commenced on the 25th March and terminated on the 18th June. The Committee reported that the nourishing properties of the biscuits were very good, and that with one exception all the horses had kept their condition and carried good coats, so that they differed in no way from the other horses in the regiment.

Calcutta.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 3, 1880.

Dr. Gilbert, Vice-President, in the Chair.

The following certificates were read for the first time:—W. E. Benton, A. H. Coffin, M. O. Gossett, A. J. King, E. Luck, W. J. Stavert, R. W. Walker, G. J. Wishart.

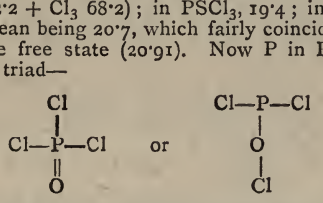
During the evening the following gentlemen were balloted for and declared duly elected Fellows of the Society:—J. O. Arnold, A. E. Barclay, J. K. Crow, A. G. Chamberlain, A. C. Cockburn, P. H. Cathcart, P. F. Frankland, T. Farrington, A. E. Garrod, A. E. Hawkes, R. Holliday, A. Jesseman, W. B. Mason, J. A. Macfarlane, H. A. Mott, R. T. Plimpton, C. H. Sharples, F. M. Sexton, B. H. Thwaite, J. H. Thompson, J. M. Wyborn. Prof. Dewar and Dr. Sprengel were elected Scrutineers of the Ballot.

The Chairman called upon Dr. Ramsay to read a paper "*On the Volumes of Sodium and Bromine at their Boiling-Points*," also a joint paper "*On the Volume of Phosphorus at its Boiling-point*," by D. O. Masson and W. Ramsay. The method already described (*Chem. Soc. Journ.*, 1879,

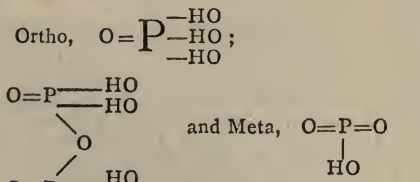
471) was used in the experiments on sodium with but slight modifications, an iron vessel being substituted for one of glass. The specific gravity of sodium at its boiling-point was found to be 0·7414: its specific volume (the reciprocal of the sp. gr.) = 1·349; the atomic volume (sp. vol. × at. wt.) = 31·0. In a similar way, the mean sp. gr. of bromine at its boiling-point was found to be 2·9483; sp. vol. 0·3392; at. vol. 27·135. With phosphorus the following numbers were obtained:—Sp. gr. 1·485; sp. vol., 0·6734; at. vol., 20·91; with a probable error of ±0·3987. The authors then compare the atomic volumes of the above elements in the free and combined conditions:—

	Free.	Combined.
Br	27·135	28·1
S	21·60	22·6 and 28·6
P	20·91	25·3
Na	31·00	not determined

The atomic volumes of bromine are identical. The at. vol. of sulphur in the free state is nearly identical with its lowest value when combined. As nitrogen is known to have at least three atomic volumes, we should expect phosphorus to have more than one: in the following compounds its atomic volume is doubtless about 25:—PCl_3, PBr_3, $PCl_2(C_2H_5O)$; but in $POCl_3$, $PSCl_3$, and $POBrCl_2$ the authors question the correctness of the calculations. The oxygen and sulphur may have the values of 12·6 and 28·6 instead of 7·8 and 22·6; if so, the atomic volume of phosphorus will become in $POCl_3$ 21·1 (mol. vol. of $POCl_3$ = 101·4 (O 12·2 + Cl_3 68·2); in $PSCl_3$, 19·4; in $POBrCl_2$, 21·7; the mean being 20·7, which fairly coincides with its value in the free state (20·91). Now P in PCl_3 is undoubtedly a triad—



In $POCl_3$ and $PSCl_3$ it may be either a triad or pentad. As the pentachloride of phosphorus furnishes $POCl_3$ by a simple and direct reaction, it is probable that the correct formula is $O=PCl_3$, and therefore we might expect the pentad phosphorus to have in this compound a different atomic volume to the triad phosphorus in PCl_3. Moreover, bromine in the free state has the same value as in combination: and sulphur has in the free state the lowest of the two values which it has in the combined state. It is therefore necessary to ascribe two atomic volumes to phosphorus, viz., 20·8 in compounds in which it acts as a pentad and when free, and 25·3 in its triad capacity. As ortho-phosphoric acid is obtainable directly from the oxychloride by the action of water, the formulæ of the phosphoric acids must be—



In conclusion, the author states that from the facts mentioned in the preceding paper the theory of "steres," as applied by Schröder to boiling liquid compounds, is untenable.

The Secretary then read a paper "*On the Specific Volume of Chloral*," by Laura Maude Passavant. Great care was taken to dehydrate the chloral used and to avoid the formation of free hydrochloric acid, which appears to have a marked influence in polymerising the substance. The chloral used in these experiments has maintained its turbidity for a considerable time, and has apparently not formed any meta-chloral. It was obtained by treating commercial re-crystallised chloral with strong oil of vitriol, and afterwards distilling it twice over lime. Its vapour-density was found to be 72·21; its boiling-point 97·73°. Its specific gravity at 0° compared with water at 4° was 1·54179 and 1·54170 in two observations. Its rate of expansion was also determined. The numbers obtained agree well with those of Thorpe, but differ from those of Kopp. As calculated from the observations of the authoress of the present paper, the relative volume of chloral at its boiling-point (97·73°) is 1·12602. Its sp. gr. at that temperature,—

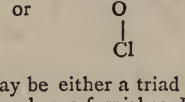
$$\frac{1{\cdot}54179}{1{\cdot}12602} = 1{\cdot}3692,$$

compared with water at 4° and its specific volume is therefore—

$$\frac{147{\cdot}01}{1{\cdot}3692} = 107{\cdot}37.$$

This number agrees well with that calculated by Thorpe (107·8), and shows that the oxygen atom in chloral has precisely the same value as in aldehyd.

Dr. Armstrong said that from the observations of Dr. Ramsay there was no doubt that the formula of oxy-trichloride of phosphorus was—



He should like to raise the question as to whether the atomic volume was a constant. To take Thorpe's paper, the atomic volume of chlorine varied between 21·6 and 23·2; the mean being 22·7. These differences seemed to him very large and outside the limits of experimental error. Although it had been shown that there was undoubtedly a great difference in this respect between an element in the triad and pentad condition, he did not think we were justified in assuming that we had determined the atomic volume of an element.

Prof. Dewar said that from the method of calculating the atomic volumes very small differences in experimental results would lead to large differences in the numbers obtained. He thought that the coincidences already obtained between the atomic volumes of an element in the free and combined state were, at all events, very striking facts.

Mr. Neison pointed out that there might be a systematic as well as an experimental error: the former could be got rid of by increasing the number of experiments.

Dr. Ramsay, in reply, said there were two reasons which might account for the variations in the experimental numbers:—The difficulty of obtaining the various substances in a pure state: and, secondly, that the atomic volumes were all determined at the particular pressure of the atmosphere: perhaps at some other pressure the atomic volumes might agree more closely. He hoped to present a paper which would answer the question whether the atomic volumes do or do not have the same ratios at varying pressures.

"*Note on the Formation of Carbon Tetrabromide in the Manufacture of Bromine*," by J. C. Hamilton. A quantity of a white crystalline substance was obtained as a residue after distilling a quantity of commercial bromine. It melted at 90·1,° and was decomposed by boiling with an alcoholic solution of soda, yielding a white precipitate of NaBr. This, on precipitation with silver nitrate, indicated 97·1 per cent of bromine in the original deposit. Carbon tetrabromide has 96·4 per cent. This substance is probably derived from the action of bromine on the organic matter in the seaweed.

Mr. Howard said that he had seen the same deposit from Scotch and American bromine: German bromine had never yielded a similar substance.

"*Researches on the Relation between the Molecular Structure of Carbon Compounds and their Absorption Spectra*," by W. N. Hartley. A preliminary notice of

the work in this paper was read at a meeting of the Society in June last. Part I. contains general conclusions as to the nature of the actinic absorption exerted by various carbon compounds. Part II. contains an account of experiments which prove the generally diactinic character of substances constructed on an open chain of carbon compounds. Part III. discusses the nature of the actinic absorption exerted by various closed chains of carbon atoms. Facts are adduced to show that the formulæ which have been proposed for camphor and camphoric acid, and for the terpenes, are correct as far as the carbon nucleus is concerned only when, in the case of the first two bodies, the nucleus is represented by a closed chain of singly-linked atoms, and, in the case of the terpenes, when the closed chain contains two pairs of doubly-linked carbon atoms. Benzene hexachloride shows no absorption-band. The following conclusion has been established:—No molecular arrangement of carbon atoms causes selective absorption unless each carbon is itself united to other than carbon atoms, as in the case of benzene. Part IV. "On the Absorption-spectra of Condensed Benzene Nuclei." The extraordinary degrees of dilution which substances like naphthalene and anthracene are capable of withstanding before all actinic absorption disappears (which were previously mentioned) have been verified. Attention is drawn to the occurrence of a series of absorption-bands in naphthalene and anthracene spectra, similar to those seen in the spectra transmitted by benzene. V. "On the Cause of Absorption-bands in the Spectra Transmitted by Benzene and its Derivatives." Theoretical considerations lead to the conclusion that general actinic absorption is due to the vibrations of molecules as a whole, but that selective absorption is caused by a series of secondary vibrations.

The Society then adjourned to December 16, when Dr. Carnelly will give a demonstration on his recent researches as to the effect of pressure on the melting-point of ice, and following papers will be read:—"The Estimation of Nitrogen by Combustion, including Nitro-compounds," by J. Ruffle; "On some Naphthalene Derivatives," by Dr. Armstrong and Mr. Graham; "On some Hydrocarbons Present in Resin Spirit," by Dr. Armstrong.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, November 2, 1880.

Edward Schunck, Ph.D., F.R.S., V.P., in the Chair.

"*On the Conditions of the Motion of a Portion of Fluid in the Manner of a Rigid Body*," by R. F. Gwyther, M.A.

"*Did Pascal Invent the Wheelbarrow?*" by William E. A. Axon, M.R.S.L.

"*On the History of the Artificial Preparation of Indigo*," by Carl Schorlemmer, F.R.S.

One of the most brilliant discoveries which lately has been made is that of the synthesis of indigo, the Indian colour which is mentioned by Dioskorides and Pliny, as well as by the Arabians. It was, however, only after the discovery of the sea passage to India that it became generally known in Europe; but its use as a dye was greatly retarded by the opposition it met with from the large vested interests of the cultivators of woad, *Isatis tinctoria*, the European indigo plant. The English, French, and several German governments were induced by the growers of woad to promulgate severe enactments against it. Thus Henry IV. of France issued an edict condemning to death anyone who used that pernicious drug called "Devil's Food." The employment of woad was, however, gradually superseded by that of indigo; and as soon as organic chemistry had advanced far enough, chemists began to examine this important colouring matter, which was first obtained in the pure state by O'Brien, who states in his treatise "On Calico Printing," 1789, that on heating indigo the colouring matter volatilises, forming a purple vapour, which condenses as a blue powder, whilst the impurities of the commercial product are left behind. Indigo-blue, or indigotin, as the pure compound is called, was afterwards analysed by several chemists, who found that its most simple formula is C_8H_5NO, which was subsequently doubled for several reasons.

The literature of the chemistry of indigo is very large. Of the numerous researches I can here mention only those bearing directly on my subject.

In 1840, Fritzsche found that on distilling indigo with potash a basic oil is produced, which he called *Aniline*, $C_6H_5.NH_2$, from anil, "by which name the Portuguese introduced indigo first into Europe. The word is Arabic, and means simply the blue." In the following year he obtained, by boiling indigo with caustic soda solution and manganese peroxide, a compound which he called anthranilic acid, and which is now known as *orthamido-benzoic acid*, $C_6H_4(NH_2)CO_2H$. He also observed that by heat it is resolved into aniline and carbon dioxide.

At about the same time Erdmann and Laurent independently studied the action of oxidising agents on indigo, and obtained *isatin*, $C_8H_5NO_2$, which is not a colouring-matter. The further examination of this body led to most interesting results, but as those are not directly connected with the subject of this paper I cannot discuss them here. We must therefore proceed at once to 1865, when Baeyer and Knop found that by acting on isatin in an alkaline solution with hydrogen in the nascent state it is converted into a yellow crystalline body, which they called *dioxindol*, $C_8H_7NO_2$. This is easily further reduced in an acid solution to *oxindol*, C_8H_7NO, which forms colourless needles, and on its vapour being passed over red-hot zinc-dust it loses its oxygen, *indol*, C_8H_7N, being formed, which is also a colourless crystalline compound, and a most interesting body, inasmuch as it is also formed, as Nencki and Kühne have shown, in pancreatic digestion, and is contained in the fæces.

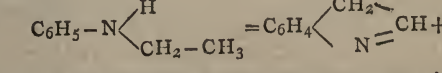
In 1869 Baeyer and Emmerling obtained indol from cinnamic acid, which occurs in several plants, and can be obtained artificially from coal-tar, as I shall show further on. By the action of nitric acid it yields two isomeric nitro-compounds. One of them, called ortho-nitro-cinnamic acid, loses, when heated with caustic potash and iron-filings, carbon dioxide and oxygen, and indol is formed, $C_8H_6(NO_2)CO_2H = C_8H_7N + O_2 + CO_2$.

The same chemists discovered (1870) a method by which isatin can again be reduced to indigo-blue. By heating it with a mixture of phosphorus trichloride, acetyl chloride, and phosphorus to 70° to 80°, they obtained a green liquid which, when poured into water, deposited, on standing exposed to the air, a blue powder containing indigotin. At the same time a purple colouring matter was formed, which they called indigo-purpurin.

It has been known for some time that urine, on standing, sometimes deposits indigo-blue. Jaffé, in 1870, found that he could produce it by the subcutaneous injection of indol; and Nencki, who confirmed this observation in 1875, was able to convert indol into indigotin by the action of ozonised air. But the yield is only very small, as the colouring matter readily undergoes further oxidation.

However, the synthesis of indigo was thus completed, because indol can be built up from its elements; but chemists were not satisfied with it, the method being neither a practical one nor giving any clue as to the chemical constitution of indigo.

In the next year Baeyer and Caro found a very simple and elegant method for preparing indol; they obtained it by passing the vapour of ethyl-aniline through a red-hot tube:—



Baeyer succeeded, in 1878, in obtaining oxindol from phenylacetic acid, $C_6H_5.CH_2.CO_2H$, which can be pre-

pared synthetically by different methods, and may be easily obtained from toluol. By treating the acid with nitric acid it is converted into the ortho-nitro compound, which is easily reduced to the corresponding amido-acid. But this, like several other ortho compounds, readily loses water and yields oxindol :—

$$CH_4\begin{cases}CH_2.CO.OH\\NH_2\end{cases} = C_6H_4\begin{cases}CH_2\\NH\end{cases}CO + H_2O.$$

This compound, as Baeyer and Knop had already found, is converted by the action of nitrous acid into nitrosoxindol. On treating this with nascent hydrogen it is transformed into amidoxindol, and this yields on oxidation isatin, the constitution of these bodies being expressed by the following formulæ :—

Nitrosoxindol.	Amidoxindol.	Isatin.
$C_6H_4\begin{cases}CH(NO)\\NH\end{cases}CO$	$C_6H_4\begin{cases}CH(NH_2)\\NH\end{cases}CO$	$C_6H_4\begin{cases}CO\\NH\end{cases}CO.$

I have already stated that isatin can be reduced to indigo-blue : Baeyer endeavoured now to find a more simple method for effecting this. By acting with phosphorus pentachloride on isatin he obtained a compound which he called isatin chloride, which nascent hydrogen converts into indigotin, $2C_8H_4ClNO + 2H_2 = C_{16}H_{10}N_2O_2 + 2HCl$.

As far back as 1869 Kekulé predicted isatin to possess the constitution which it has been proved to have by Baeyer's researches, and two of Kekulé's pupils, Claisen and Shadwell, discovered in 1879 a very simple synthetical method for preparing it. By acting with phosphorus chloride on ortho-nitro-benzoic acid, $C_6H_4(NO_2)CO_2H$, the chloride, $C_6H_4(NO_2)COCl$, is formed, which when heated with silver cyanide yields the nitrile, $C_6H_4(NO_2)COCN$. On heating the latter with a solution of caustic potash it is converted into ortho-nitro-phenyl-glyoxylic acid, $C_6H_4(NO_2)CO.CO_2H$, and this is converted by nascent hydrogen into the amido compound, which, like other otho compounds, loses water and yields isatin.

I have now given you a sketch of the history of artificial indigo up to 1879, when I wrote :—"The artificial production of indigo has so far merely a theoretical interest; whether the time will come when simplified methods will admit of its manufacture on a large scale remains to be seen. But even if not, the indigo-purpurin, which is always formed together with the blue, may become of importance as a colouring matter. This body, as Dr. Schunck has shown, is identical with his *indigorubin*, which always occurs, but in small quantity only, in indigo. Dr. Schunck has traced the formation of this beautiful purple colour in *Polygonum tinctorium*, a plant used in China and Japan for the preparation of indigo. He has cultivated it for several years, and found that the young plants do not contain a trace of it. It can be only obtained from plants having attained an advanced stage of development. It dyes under the same conditions as indigotin does; but while the latter dyes a dull dark blue, indigorubin dyes a fine purple shade. Dr. Schunck, who is an authority on these matters, is of opinion that if it could be obtained in quantity it would be a most valuable addition to the colours now in use."*

Since this has been written Baeyer has succeeded in finding a method which to all probability will soon be employed for the manufacture of indigo-blue on a large scale. The starting-point is from cinnamic acid, which occurs in nature, being found in gum-benzoin, styrax, balsam of Peru, and a few other aromatic bodies. These sources would be, however, far too expensive, and the quantity obtained therefrom much too small, to make use of them. Now, Bertagnini found, as early as 1856, that this acid may be obtained artificially by heating benzaldehyd, or oil of bitter almonds, with acetyl chloride,—

$$C_6H_5.CHO + CH_3.COCl = C_6H_5.C_2H_2.CO_2H + HCl.$$

* "The Rise and Development of Organic Chemistry." Manchester: Cornish.

Since that time several processes have been found for obtaining oil of bitter almonds from toluol and from benzoic acid. The first point to be settled was therefore to ascertain which is the cheapest and best method for preparing this compound, as well as acetyl chloride, which is produced by the action of phosphorus chloride on acetic acid.

W. H. Perkin, F.R.S., has discovered another synthesis of cinnamic acid, which probably may also be of practical value. He obtained it by boiling benzaldehyd with acetic anhydride and sodium acetate.

By the action of nitric acid on cinnamic acid we obtain ortho-nitro-cinnamic acid, $C_6H_4(NO_2)C_2H_2CO_2H$, which readily combines with two atoms of bromine to form dibrom-nitro-phenyl-propionic acid. This compound, by the action of alkali, is transformed into ortho-nitro-phenyl-propiolic acid,—

$$C_6H_4(NO_2)C_2H_2Br_2.CO_2H + 2NaOH = C_6H_4(NO_2)C_2.CO_2H + 2NaBr + 2H_2O.$$

The latter acid yields pure indigo when its alkaline solution is heated with a reducing agent, such as grape-sugar, indigotin being deposited in the crystalline state,—

$$2C_9H_5NO_4 + 2H_2 = C_{16}H_{10}N_2O_2 + 2CO_2 + 2H_2O.$$

Besides this method Baeyer has patented some others in which also cinnamic acid is used. These processes are now worked out by two of the greatest colour works on the Continent.

How far the artificial production of indigo will be a commercial success remains to be seen. As far as I understand, it is at present only intended to manufacture nitro-phenyl-propiolic acid, which, when mixed with an alkali and grape-sugar is printed on the cloth. By the action of steam a pure indigo-blue is produced, which would form a most valuable addition to the host of steam-colours which are now so largely in use.

In conclusion I must mention another of Baeyer's discoveries which promises to be of practical value. We can easily replace in isatin one atom of hydrogen by bromine, the nitro group, amido group, &c. By subjecting these substituted isatins to the action of phosphorus chloride they are converted into chlorides, and these yield, by treatment with reducing agents, substituted indigos. These bodies are all coloured, and their properties are very similar to those of indigo. It appears not improbable that some of them might find application in dyeing or printing, and be prepared, not from isatin, but from substituted cinnamic acids.

When, twelve years ago, the artificial madder colours were discovered, it was not believed that they could be produced in sufficient quantity nor cheap enough to compete successfully with the natural colours. To-day the cultivation of madder has almost ceased: whether this will happen in the case of indigo is a question which I think will soon be solved.

THE AMERICAN CHEMICAL SOCIETY.*

The October meeting of the Society was held on Thursday, October 7, 1880, at University Building, New York. Dr. E. R. Squibb presided.

The following gentlemen were elected :—*As Members*—C. H. Torry, School of Mines, New York; G. T. Bihn, Philadelphia, Penn.; Dr. Karl Stahl, Chicago, Ill.; Hermann Poole, Buffalo; N.Y. *As Associate Members*—J. R. Savage, Philadelphia, Penn.; Thomas Harrison, Philadelphia, Penn.

The following gentlemen were nominated :—*As Members*—Albert C. Hale, Golden, Colorado; Narcisse Pigeon, New York City; Theodore Lungwitz, Jersey City; Byron N. Wittmann, Reading, Pa.; Henry J. Seeman, Catasauga, Penn.; Chas. W. Schmich, Arbisonia, Penn.; Dr. Henry Friedburg, N.Y. *As Associate Members*—Hermann T.

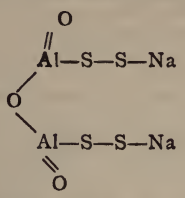
* Communicated by Arthur H. Elliott, F.C.S., Recording Secretary.

Vielté, School of Mines, N.Y.; T. G. Wiechmann, School of Mines, N.Y.; T. D. O'Connor, School of Mines, N.Y.; Charles Kyte, jun., London, England.

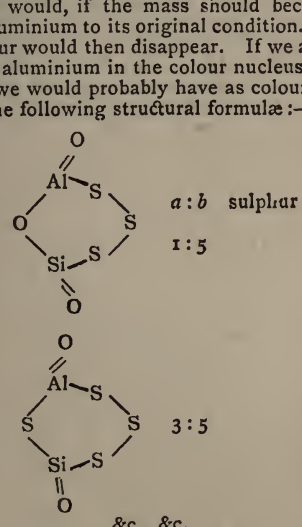
The following paper was read :—"*On the Constitution of Ultramarine*," by H. Endemann, Ph.D. (This paper has appeared in full in the Chemical News.)

In the discussion which followed the reading of this paper, the author made the following statements :—

Most of the ordinary ultramarines of commerce appear to contain a colour nucleus of the following composition :—



Which must be considered as being derived from a white or green ultramarine containing already interpolated sulphur. The action of aqueous acids will produce from such a compound H_2S+3S. The action of chlorine upon green ultramarine, when blues are obtained containing interpolated sulphur while but little chloride of sulphur is formed, is equivalent to the action of chlorine upon sodium sulphide where also polysulphides are obtained. The action of hydrogen chloride upon white and green ultramarines is insufficiently studied. It is stated that no sulphuretted hydrogen is produced; this, however, is true only to a certain extent. The blue obtained by this process contains the same, or nearly the same, quantity of sulphur as the green ultramarine. If we should accept for the blue thus produced the same formula as for the one ordinarily produced in the manufacture an evolution of hydrogen would have to be accepted. No investigations to prove its presence in the products of the reaction have as yet been made. Further research upon this subject is therefore desirable. The silicate rest must not be considered as acting in the manner of a flux. The large excess of silica in it would, if the mass should become melted, reduce the aluminium to its original condition. "Alumina" and the colour would then disappear. If we accept silicon as replacing aluminium in the colour nucleus to the extent of one-half, we would probably have as colour nuclei compounds of the following structural formulæ :—



That is, we might then consider the colour nucleus to be free from sodium. Whether this is not really the formula can only be determined by experiment. If by the conversion into red and yellow a further loss of sodium can be demonstrated we should adhere to the formula containing aluminium mainly, with perhaps partial substitution by silicon. If no such loss takes place this latter view of the composition of ultramarine becomes more probable. Considering, however, that in silver ultramarine which is obtained from ordinary ultramarine by replacing the sodium by silver, not all the silver can be accepted as being in the same relative position to the other constituents, some of it being easily converted into chloride, while the rest cannot be thus attacked. The author, therefore, is inclined to consider the blue ultramarine as being derived mainly from aluminium. The silicate rest is then only by its properties, and perhaps an analogous constitution, favourable to the existence of the colour.

The following papers by Prof. Wiley, of Lafayette, Indiana, were read by title and referred to the Committee on Papers and Publications :—"The Rotary Power of Commercial Glucose and Grape-Sugar : A Method of Determining the Amount of Reducing Substances Present by the Polariscope." "The Effect of Heating with Dilute Acids and treating with Animal Charcoal on the Rotary Power of Glucose.

NATIONAL ACADEMY OF SCIENCE, NEW YORK.

November 16, 1880.

At the opening of the afternoon session Professor Gibbs explained a new general method in analysis discovered by himself and brought to a certain degree of perfection by experiments. The former process of determining metals by electrolysis, he said, had been found operative with only one or two metals, such as cadmium and mercury. The new method was simply to place the metal in solution in a beaker, add pure mercury, and connect the mercury with an electric battery. By the electric action the metal was thrown down upon the mercury. It was necessary only to weigh the mercury and the beaker beforehand, and then after the process to determine the metal by again weighing the vessel and the mercury. This method, he said, was applicable to mercury, tin, cobalt, and other metals. It did not apply in arsenic and antimony. He did not despair of separating potassium and sodium by the process, although his experiments with these metals had not been completely successful.

Professor Hunt said this process came with the beauty and force of a revelation; its simplicity recommended it. Every chemist would await further developments with great interest. He also asked what battery power was used.

Professor Gibbs said the power of the battery was immaterial except in point of time. The stronger the power the shorter the time required for the process.

Electric Lights.

Professor Morton's first paper treated of some recent experiments made by him in determining the electro-motive force of the Brush dynamo-electric machine. Various instruments for the accurate measurement of electric currents of great strength were first described, and then the measurements of potential in the above-mentioned machine. These showed that each pair of coils on the armature of the machine developed a fluctuating electro-motive force, the projection of which gave a kind of oval curve around the centre of the diagram.

When these curves for each pair of coils are combined, it is found, Professor Morton said, that they show a kind of eight-lobed figure with intersecting lines in certain places. These intersections, if compared with the positions of the commutator, are found to coincide exactly with the points at which rupture of circuit occurs, and thus show that each pair of coils is thrown out, not at the point where its force is least, but at that at which its electro-motive force is equal to that from which it breaks; thus suppressing a spark, but only at a certain sacrifice of theoretical efficiency.

Professor Morton also read a paper on the measurement of new forms of electric lamps operating by incandescence. After explaining his method of measurement,

he gave the results of a number of experiments which he had recently made with the new Maxim lamp. In this lamp a filament of carbon made from any carbonisable substance, such as paper or card, is placed in a globe. The globe is exhausted of air to a certain point and filled with the vapour of gasoline. The electric current is then passed through the globe. By a singular action the decomposed gasoline deposits carbon upon the filament at the point where it is weakest, and therefore hottest. This portion thus finally becomes of the same conductivity with the rest of the filament, when the action of the intense heat seeks out the next weakest point of the filament, and this process is repeated indefinitely. This property of self-correction, Professor Morton said, was of great importance. The capacity of the lamp for developing light is remarkable. One of these lamps, showing a light of 40 candles, was run to 240 candles per horse-power; another of 52 candles, in reference to power, was run to 336 candles per horse-power; another of 12 candles was run to 136 candles per horse-power. This latter lamp, with the light increased to 49 candles, was run to 426 candles per horse-power, and with the light of 98 candles was run to 607 candles per horse-power. This was far within what the lamp would stand. It could be run to 250 candle-power, and it is said, it has been run to 1500 candles. The law of the increase of efficiency with the increase of the intensity of action was thus verified in this as in other cases. It has also been found that the resistance decreased with the increase of temperature.

Professor Gibbs expressed much astonishment at the results obtained by Professor Morton, and said that nobody had dreamed that the light of incandescence could compete with the light of the arc.

Professor Morton explained that his references to horse-power had been to the power in the electric current, measured in the usual way, and not to the power in the machine. He added that he would greatly like to compare the Maxim lamp with Edison's latest lamps provided with filaments of bamboo cane. By an accident to his apparatus, Mr. Edison had not been able to redeem a promise to send Professor Morton one of his lamps, but Mr. Edison had written him to the effect that his latest lamps with 16 candle-power, had been run to 55 candles per horse-power. This, Professor Morton remarked, was a decided improvement upon the efficiency of Mr. Edison's horse-shoe lamp. This result compared with the result obtained with the Maxim lamp as 155 to 240.

Professor Barker said that he was much interested in the Edison and the incandescent lamps, and that the statements made by Professor Morton certainly marked a year of great progress in electric lighting. One of the greatest difficulties had been in making a fibre that would not disintegrate. A bamboo fibre at fifty candle-power lasted about an hour. The lamp of Mr. Maxim was a great step in advance, it practically caused the fibre to last indefinitely. He understood that Mr. Edison had recently been working in the same direction.

Professor E. D. Cope followed Professor Morton with two papers on Nimravidæ and Miocene Canidæ. He described certain types of Felidæ now extinct, and ascribed their destruction to lack of food supply. Their functions were the same as those of the present Felidæ. Like these, only in a greater degree, they destroyed a larger portion of life than they were able to consume.

GERMAN ASSOCIATION OF NATURALISTS,

The Fifty-third Meeting, at Danzig,

September 18 *to* 24, 1880.

On Monday, the 20th September, the scientific proceedings of the only Section opened began by the reading of a paper by Dr. Emmerling, from Kiel, on "*Acetol and Grape Sugar*," after having been put off, owing to the absence of the author.

Some time ago the author, in company with Dr. Richard Wagner (as has been published in *Liebig's Annalen*), was engaged with the recovery of the hydroxyl compounds of the acetons from the so-called acetols, and, indeed, he performed it by the action of argentic oxide and water on mono-brom-aceton, but more completely by treating the latter with potassic carbonate, because by this method a great number of disagreeable by-products are avoided. The acetol itself, as only few bodies do, reduces alkaline oxide of copper in the cold, in fact one part of acetol will reduce two parts of oxide of copper; even a very dilute solution of this body possesses this property. Up to the present this has not been accomplished when free from water. All the methods which have been attempted for this purpose, such as the use of chloride of lime, anhydrous sulphate of copper, or potash, destroy it; fractional distillation succeeds no better than freezing; both methods would from combination at last form a solution, which would contain at the most only 11 per cent of acetol. This solution has a sweetish taste, resembling walnuts; it happens to have the same boiling-point as water, and reduces besides copper also silver and bismuth. By its oxidation with potassic chromate, acetic and carbonic acids are produced, thus—

$$CH_3COCH_2OH + O_3 = CH_3COOH + CO_2 + H_2O.$$

By the action of potash-lye on grape-sugar, a similar distillate to the above was obtained, which showed the same property of reducing, although in a much less striking manner. From this time the author, in company with Dr. Loges, so changed the experiment that by putting into anhydrous melted grape-sugar small pieces of potash, he obtained as distillate a body which exists probably as a mixture of two different bodies. One with a boiling-point from 90° to 95° has not yet been examined; the other watery portion, however, behaves in a remarkably similar manner to the already-described acetol, both in its power of reduction and in its products of decomposition; only in the latter case the formation has been found to be 2 molecules of acetic acid to 1 molecule of CO_2, from which it is probable that the new compound contains 5 atoms of carbon in a molecule. Hence it follows that we probably have to do with a keton-alcohol in this case, which, like benzoyl-carbinol and acetol, shows the property of great reducing power. At the conclusion several proposals were made for preparing acetols free from water, by means of diffusion, meta-phosphoric acid, &c.

Dr. Schulz, of Strasberg, Alsace, then proceeded to read a paper "*On the Constitution of Phenanthrens*," in which he chiefly tried to prove what was earlier supposed by Fittig and Ostermayer in *Liebig's Annalen*, namely, that it is a derivative of diphenyl-carbinol.

To this followed a discourse by Dr. Scheibler, from Berlin, "*On Saccharin*." The constituents of sugar divide in such a manner that one part remains unaltered by acids and the other unaltered by alkalies. Cane-sugar under the influence of acid turns to glycose, which again separates into two compounds, distinct one from the other, and which are known as dextrose and lævulose, while this last, by the action of alkalies, separates into the utmost products of decomposition. A mixture of dextrose and lævulose, treated with milk of lime, is coloured a dark brown-red; by separation of the mixture, a chamois yellow lime-salt with an acid, as yet little known, of which one is soluble in ether. After filtration the dissolved lime is precipitated by means of oxalic acid, the filtrate is evaporated until it is of a syrupy consistency, and then left to crystallise. In this manner, bodies in rhombic crystals, having the formula of cane-sugar, are obtained; these have the melting-point of cane-sugar, about 160° to 161°, and are characterised by their property of being entirely volatilised on the application of heat. This is a property which has not yet been noticed to be possessed by saccharine bodies. The rotatory power of saccharine is, although arising from the so-called sugar mixture of dextrose and lævulose, only right-handed, and, indeed, it

is as strongly marked as with cane-sugar; the dextro-rotatory power of the latter is +67·2°, and that of saccharine is +93·5°. Reduer has also examined the acetyl-compound, and it is found to be a thick cohesive fluid, which is undecomposed on distillation. Saccharine, similar in relation to its crystalline form, is a body discovered previously by Berthelot, which he named trehalose; it has a rotatory power of +199°, and its formula is $C_{12}H_{26}O_{13}$; and arabinose, from gum-arabic; or, also, as the preceding shows, what may be represented a beet-sugar, having a rotatory power of +121°, and the formula $C_{12}H_{24}O_{12}$. It is worthy of remark that the angle of the prism of saccharine, arabinose, and of trehalose amounted to 111° and some minutes.

Then followed a discourse by G. Westphal, from Celle, Hanover, on a new contrivance patented by him for adjusting the beam of a chemical balance. By means of this arrangement it is possible to entirely adjust the beam in every position. First of all the level of the balance is established, then the parallelism of the beams, and after that the angle of oscillation, and lastly the length of the arms. Each separate adjustment can be done independently of the others, and can be proved by weighing, so that it is by this means easily possible for the chemist or physicist to adjust his balance for most delicate weighing in the shortest time. The details were shown by a model, and the whole was put together; so as to prevent errors in weighing, the whole arrangement, even the stand, was platinised, which offers a surer protection against mercury than gilding does. Further, a revolving weight table with glass surface was shown, which renders the handling of the weights much easier, and also contributes much to the appearance of the whole.

In regard to platinising, Professor Böttger, from Frankfort, gave a short notice on a process, the design of which is to get good results by the wet way. It depends entirely on the possibility of getting a large quantity of ammonio-chloride of platinum in solution, and it appears that a moderately concentrated solution of citrate of soda best fulfils this purpose. Two small Bunsen elements are quite enough to effect the electrolytic decomposition, and to deposit a regular durable coating of platinum.

In another discourse by Dr. Blockmann, from Königsberg, the question was raised—Why does the gas mixture of a Bunsen burner burn with a luminous flame after being heated? If, in the top of a Bunsen burner, a platinum tube, which can be very easily made from thin platinum foil, is placed, and this tube is heated to dull redness by means of another burner, the previously non-luminous flame will become luminous, and will even give the same amount of light as pure coal-gas. This phenomenon has been explained in the following manner:—Luminous flames can by the withdrawal of heat (such as mixing N, CO_2, or H_2O) be made to burn non-luminously, and, on the other hand, non-luminous flames are caused to burn brightly by the addition of heat. In a like manner, it is said, the luminosity of the flame in the above-described experiment depends entirely on the temperature which the gas experiences when passing through the heated platinum tube. This manner of accounting for it did not satisfy the lecturer. First of all he believed that it must be found whether or not the mixture of gas and air undergoes a change in its chemical composition upon contact with the glowing platinum. Analysis alone can clear up this point. Therefore the mixture of gas and air passing through the platinum tube was collected before and during the heating and analysed. The mixture before heating contained in round numbers 60 per cent air and 40 per cent coal-gas. After passing the heated portion, the greatest part of the hydrogen and all the oxygen had disappeared, the marsh-gas and the heavy hydrocarbons of the coal-gas showed only a slight decrease, and the carbonic oxide a slight increase; the products of combustion were 22·2 volumes of steam, and 1·4 volumes of carbonic acid. The platinum foil (10 c.m.×8 c.m.), which had served for all the other experiments, was then rolled up into a spiral form, and pushed into a difficultly fusible glass tube of the same width as the Bunsen burner. The gas mixture was then passed through and heated, and even by daylight the platinum spiral was distinctly seen to remain red-hot after the withdrawal of the flame, and water collected in perceptible drops in the cooler part of the tube. The gas mixture which had passed over the heated platinum contained only 20 per cent of inflammable constituents, 55 per cent of nitrogen, and 25 per cent of products of combustion, and was generally on the verge of inflaming. The flame was not luminous, and appeared already partly destroyed, and belongs, as we see, to the categoric non-luminous flames from inert gases. By warming from the outside the flame was not made to be luminous, for the attenuation was too great. Also by making a mixture of gas and air in a gasometer, and then allowing it to pass through the same Bunsen burner and igniting it, it was not possible to make the flame luminous, however much the platinum tube was heated. This experiment proves that the reason of the luminosity of flames under the conditions in question, namely, the raising of temperature which the gas experiences by passing through the glowing platinum tube, is not to be found. The speaker then proceeded to consider the manner in which the air enters the Bunsen burner, and the action which the heating of the tube of the burner has on the motion of the gas inside, and it was found that according to the amount of heating that the air was partly or entirely hindered from entering the air-holes at the bottom of the burner. By this the original conditions of the air and coal-gas were changed, as though the air-openings were entirely shut, and only for this reason was the flame luminous.—*Chemiker Zeitung.*

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 19, November 8, 1880.

Heat of Formation of Dimethyl and its Relations with the Methylic and Ethylic Series.—M. Berthelot.—The author maintains that dimethyl or ethylene hydride constitutes a link, at once theoretic and experimental, between the methylic series—toward which it plays the part of a radicle both by its formula and its origin—and the ethylic series which it develops by its methodical transformations. Between formene and dimethyl pyrogenous reactions even establish the existence of certain mobile equilibria where these two bodies produce each other reciprocally. The transformation of formene into dimethyl takes place by the separation of hydrogen according to the same volume proportions as the decomposition of the hydracids. The thermic relations between dimethyl and the methylic compounds do not differ greatly from those which exist between hydrogen or the easily reducible metals and their binary compounds. But there is this essential difference that hydrogen and the metals play the part of radicles, both analytically and synthetically, whilst dimethyl, formed analytically at the expense of the methylic compounds, does not in general reproduce them by direct synthesis.

Preparation of a New Alimentary Substance, "Nutricine."—E. Moride.—This mixture is made up of muscular flesh, freed from bones, tendons, &c., along with farinaceous substances slightly stove-dried.

Transformation of Oxygen into Ozone by the Electric Effluve in Presence of a Foreign Gas.—P. Hautefeuille and J. Chappuis.—A very small quantity of chlorine serves to prevent the transformation of oxygen

into ozone. If a very small volume of chlorine is introduced into ozonised oxygen, the ozone is completely destroyed during the act of electrisation, a very unstable chlorine compound being probably formed. Nitrogen mixed with oxygen enables the latter to be transformed into ozone in a larger proportion than if the latter gas were present alone. Hydrogen and silicon fluoride do not hinder ozonisation.

Action of Chlorine and of Hydrochloric Acid upon Lead Chloride.—A. Ditte.—When at a given temperature chlorine is passed into a liquid containing an excess of lead chloride and increasing quantities of hydrochloric acid, this gas, acting at first upon the chloride dissociated by the water, forms lead peroxide and hydrochloric acid, between which a particular state of equilibrium is established. As the quantity of acid augments there are produced larger and larger quantities of perchlorinised lead hydrochlorate, always dissociated in such a manner that the liquid contains constantly hydrochloric acid and free chlorine.

Combinations of Ammoniacal Gas with Palladium Chloride and Iodide.—M. Isambert.—There is no essential difference between the combinations capable of giving rise to ammonio-metallic chlorides and those merely known as ammoniacal chlorides. The heat of combination is merely greater in the first case than in the second.

The Formation of Chloroform by Alcohol and Chloride of Lime.—A. Béchamp.—Experiment confirms the theory that the alcohol attacks the hypochlorous acid itself in the hypochlorite, the chlorine and hydrogen of which simultaneously remove hydrogen from the alcohol; afterwards the chlorine goes on removing hydrogen, for which the oxygen is substituted, producing chloral, which is split up by the hydrate of lime.

No. 20, November 15, 1880.

Researches on Isomerism: Benzine and Dipropargyl.—MM. Berthelot and Ogier.—The authors have not succeeded in the direct conversion of dipropargyl into benzol, but their experiments have shown the great aptitude of the former body to become polymerised, as theory requires. There is liberation of heat and consequently loss of energy, either when several distinct bodies combine to form a new substance (combination property so-called); or when several identical molecules unite to form a more condensed body (polymerism); or, lastly, when a body endowed with a certain capacity of saturation is transformed into an isomeric body of the same degree of condensation, but whose aptitude to combine with other bodies by addition is smaller (kenomerism). There is then a sort of internal saturation effected in the substance, in accordance with the hypothesis of an interchange of atomicities among the elements. Their studies on terpilene as compared with camphene, and on dipropargyle compared with benzol, give these notions a surer basis and a mechanical significance. Phenomena of this order may be produced in the formation of a great number of other compounds, such as the metallic oxides and the bodies known only in a single state, whose ultimate capacity of saturation is diminished by these phenomena.

On Papaine: A New Contribution to the History of the Soluble Ferments.—A. Wurtz.—Papaine was found to dissolve a thousand times its weight of most fibrin, the greater part of which was transformed into a pepton not precipitable by nitric acid. In consequence of the complete hydration of the fibrin there is even formed a small quantity of a crystalline amidic body.

Enrichment of Plumbiferous Earth by Means of a Stream of Air.—M. Delesse.—A blast apparatus has been employed to remove the lighter particles from certain pure plumbiferous earths, containing originally not more than 7 per cent of metal. The process was not found applicable when the grains of earth were very minute. The proportion of silver was found to decrease as that of lead increased. The process did not work satisfactorily with the galena of Génolhac with a quartzose and dolomitic gangue.

Compressibility of Oxygen, and the Action of this Gas on Mercury in Experiments where these Bodies come in Contact.—E. H. Amagat.—The author affirms that under the conditions of pressure and temperature at which his experiments have been conducted, mercury and oxygen, both perfectly pure and dry, may remain in contact for a time longer than is required for experimental purposes without the least absorption being perceptible.

The Liquefaction of Ozone in the Presence of Carbonic Acid, and on its Colour in the Liquid State.—P. Hautefeuille and J. Chappuis.—We have ascertained that the sudden liberation of ozonised oxygen from pressure occasions the formation of a dense mist, the certain sign of a change of the condition of the ozone; but is it possible to obtain this body in the state of permanent drops, and is the liquid ozone coloured? This is what we have endeavoured to find out by compressing, with the precautions indicated in a former memoir (*Comptes Rendus*, xci., p. 522), ozone prepared at the low temperature produced by passing a current of dry air into methyl chloride. This gas, compressed at 200 atmospheres in the capillary tube of Cailletet's apparatus cooled down to $-23°$, assumes a blue colour, which becomes deeper and deeper as the pressure increases, but which does not yield a visible liquid distinguishable from the gas by a meniscus. If we place the upper portion of the capillary tube in liquid nitrogen protoxide, the intensity of the colouration augments considerably in this portion, which is cooled to $-88°$. The lower part being kept at $-23°$ we may judge of the difference of the shade, and estimate that the ozone at $-88°$ is three or four times more deeply coloured than at $-23°$. The intensity of the colouration increases, therefore, as the temperature falls. After a few minutes the temperatures of the two portions of the tube differ but little, and the gas takes a uniform deep blue colour. The ozone is then imprisoned in a vessel closed by solidified mercury, the meniscus of which remains brilliant and absolutely unattacked by ozone at this low temperature. Under these conditions it may be ascertained that the capillary tube does not contain a drop of liquid. Do these experiments prove that ozone is blue in the liquid state? Such a conclusion would be strained, for if a gas becomes more deeply coloured on cooling it does not follow that it would retain its colour on a change of physical condition, although in hyponitric acid we find that the colour of the liquid acid and that of its vapour differ so much the less as the temperature falls. But we may endeavour to determine the liquefaction of ozone by adding to the mixture of ozone and oxygen a large proportion of carbonic acid; an artifice which has enabled us to recognise new facts. The comparative study of the mixtures of oxygen with ozone and with carbonic acid has shown us that the liquefaction point of ozone differs little from that of carbonic acid. Not being able sufficiently to increase the proportion of ozone in the mixture, so as to diminish the retardation which a large proportion of a permanent gas occasions in the process of liquefaction, we added carbonic acid to the ozonised oxygen. The compression in a capillary tube kept at $-23°$ by means of chloride of methyl, of a mixture of carbonic acid, and of oxygen ozonised at a very low temperature, gives results analogous to those obtained with mixtures of several liquefiable gases, but which are in this case rendered quite distinct. Slow compression enables us to obtain a liquid separating itself from the gas by a mixture; this liquid is not colourless, as is the case with liquid carbonic acid; it is decidedly blue, and its shade does not seem to differ from that of the gas above. This is a stable condition, which is permanent as long as the gases remain under pressure. If we slightly release the gases and immediately compress again, we see above the mercury a sky-blue liquid column, much more deeply coloured than the gas. The cold of the release occasions an abundant vapour formed of carbonic acid and of ozone in the liquid or solid state, for the

latter body is then cooled below its critical point, and the plentiful liquefaction of the carbonic acid produced by compression collects a portion of this ozone. What proves that the matter takes place thus is that the colouration of the liquid diminishes, and that in a few minutes the liquid and the gas take the same shade. The ozone collected at first by the liquid carbonic acid becomes diffused, the atmosphere of the tube not containing the vapour of ozone in a state of saturation. In the same manner as the compression of a mixture of oxygen, carbonic acid, and nitrogen monoxide gives a mixed liquid formed of the two liquefied gases, a mixture of oxygen, carbonic acid, and ozone gives a mixed liquid containing liquefied ozone; this ozone gives a blue colour to the liquid obtained in our experiments. These facts enable us to foresee that we should obtain ozone in liquid drops by compressing at a very low temperature the mixture of ozone and oxygen prepared at −88°, the proportion of ozone rising according to our experiments to more than 50 per cent, and that under these conditions we should have a very deep blue liquid. Colourations have already been employed in chemistry to solve controversy questions. It is sufficient to refer to the experiments of M. H. Sainte-Claire Deville on the dissociation of phosphorus perchloride and mercury iodide. The colouration of ozone in the liquid and the gaseous state enables us to show that the products of the decomposition of carbonic acid by the effluve contain a large proportion of ozone. For this purpose it is sufficient to compress them, which is easily effected by transforming the reservoir of Cailletet's tube into an effluve apparatus in which the carbonic acid is submitted to electric discharges for several hours before being compressed. The compression of the gas cooled down to −23° gives a gas as coloured as its proportion of ozone indicated by M. Berthelot admits of, and at a certain pressure the carbonic acid which has not been decomposed liquefies and turns blue. We establish thus, without any reagent, the large proportion of ozone found in the oxygen derived from the decomposition of the carbonic acid. This conclusion is what has been already indicated in a former paper (*Comptes Rendus*, xci., p. 762), and it is conformable to one of the hypotheses laid down by M. Berthelot on the nature of the oxidising product formed from carbonic acid by electric discharges.

On Malleable Cast-iron.—M. L. Forguignon.—Malleable cast-iron appears as an intermediate body between steel and grey pig-iron, from which it differs by the special nature of its amorphous graphite, and by its greater tenacity; it is distinguishable from steel by its slight extensibility and its large proportion of graphite.

Inflammation-Temperatures of Gaseous Mixtures.—MM. Mallard and Le Chatellier.—The detonating mixture of hydrogen and oxygen explodes between 552°—569°, and this temperature is only lowered by 30° if the proportion of oxygen is increased by one half. The addition of nitrogen to the mixture scarcely causes any difference in the temperature of ignition, which, however, is increased a little by the addition of carbonic acid. The detonating mixture of carbonic oxide and oxygen explodes at 647·5°, and large variations in the proportions of the gases scarcely affect the temperature. An addition of nitrogen has little influence, but the presence of carbonic acid raises the temperature notably. Detonating mixtures prepared with hydrogen monocarbide have not, properly speaking, any precise and definite temperature of ignition, but it is not higher than 790°, and ignition may take place much lower.

MISCELLANEOUS.

Alkali Waste as a Manure.—At a recent meeting of the Farnworth Agricultural Society, Mr. Gossage called the attention of the farmers present to the value of alkali-waste as a manure. This substance is well known to have accummulated in the Widnes district to a serious extent, and any method by which it might be utilised or even got rid of would prove a great boon to the neighbourhood. Mr. Gossage informed his hearers that alkali-waste consists of calcium sulphide and sulphate, the former ingredient rendering it a valuable application for land foul with weeds, noxious insects, &c., whilst the sulphate, otherwise known as gypsum, fixes ammonia and decomposes the alkaline silicates of clay soils, thus rendering their potash available for the demands of vegetation. He recommends it to be applied to the extent of about 25 to 50 tons per acre, being spread evenly over the fields early in the autumn, and left to lie for a month or six weeks before being ploughed in. He adds the caution that a sufficient time must be allowed to pass over before any seed is sown in land which has been thus treated. As, however, the production of alkali waste at Widnes amounts to 1000 tons daily, it appears doubtful if a sufficient quantity of land requiring such dressing is to be found within prohibitive distances. Nor must it be forgotten that the constant application of a manure which supplies neither nitrogen, phosphoric acid, nor potash, cannot be long continued. From the fact that fresh applications have still to be sought for alkali-waste it may be inferred that the success of the processes for the regeneration of the sulphur present is less decisive than might be wished.

MEETINGS FOR THE WEEK.

MONDAY, 13th.—Medical, 8.30.
—— Royal Geographical, 8.30.
—— London Institution, 5.
TUESDAY, 14th.—Civil Engineers, 8.
—— Medical and Chirurgical, 8.30.
—— Photographic, 8.
—— Anthropological Institute, 8.
WEDNESDAY, 15th.—Society of Arts, 8.
—— Meterological, 7.
—— Geological, 8.
THURSDAY, 16th.—Royal, 4.30.
—— Chemical, 8. "The Estimation of Nitrogen by Combustion, including Nitro-compounds," by J. Ruffle. "On some Naphthalene Derivatives," by H. E. Armstrong and N. C. Graham. "On some Hydrocarbons Present in Resin Spirit," by H. E. Armstrong.
—— Philosophical Club, 6.30.
—— London Institution, 7.

TO CORRESPONDENTS.

Geo. Pennington.—"Destructive Distillation," by Dr. E. J. Mills London: Van Voorst.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

ROYAL POLYTECHNIC.—The Breath of Life, or the Oxy-hydrogen Microscope, by Mr. J. L. King. A Trip through China, by Mr. Heath. A Walk through the Tower, by Mr. J. L. King. Bombastes Furioso, a Burlesque. Inspection of going Machinery, Processes and Exhibits. Recitals in Costume, by Madame Katharine Hickson. Performances of the Automata, Blondin and Leotard. The Illuminated Fountain and Ball Floating in the Air. Descent of the Diving Bell. Admission 1s. Open from 12 till 5, and from 7 till 10.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

PROSPECTUS.

DINGLER'S POLYTECHNIC JOURNAL.

(DINGLER'S POLYTECHNISCHES JOURNAL.)

A Scientific Review of Useful Knowledge in Natural Philosophy, Chemistry, Pharmacy, Mechanics, as well as in all kinds of Manufactures, Arts, Trades, &c.

EDITED BY

JOHANN ZEMAN and Dr. FERD. FISCHER.

PUBLISHED BY

J. G. COTTA, Publisher at Stuttgart and Augsburg.

62nd Year. Terms of Subscription: One year, 36 mark (£1 16s.) Three months, 9 mark (9s.)

We think it advisable, in the interest of the public, to point out the aim which the editors of "Dingler's Polytechnic Journal" have always had in view, and the importance of which is shown by the large number of readers this Journal has found among men of science, manufacturers, engineers, &c. Our aim is to give a *complete* and *exhaustive review* of all remarkable facts in the wide field of applied natural sciences.

A *complete* review, inasmuch as our journal, by means of special articles and repoits, will not only treat of every new scientific fact in *Germany*, but will also make its readers acquainted with the industrial progress achieved by *foreign countries*, and this through our special correspondents as well as by profiting of foreign publications.

An *exhaustive* review we mean to give in this sense, that we will not be satisfied with simply illustrating and describing our subject matter, but *thoroughly explaining* the same from a theoretical and practical point of view.

Edited in such a manner, "Dingler's Polytechnic Journal" since its foundation in 1820 has always been increasing in importance and public favour, so that it can bear comparison with the principal scientific journals even of countries that occupy the first rank with regard to their industrial development; as to the richness and variety of its information, it is unrivalled.

The *lists of names* of these volumes contain, for the years 1875, 1876, 1877, 1878, and 1879, respectively 925, 950, 1300, 1600, and 1950 names of authors and inventors mentioned in the text of the Journal.

The *index*, in which every article or communication is mentioned under all its reference-words, contain from 2500 to 3000 titles.

"Dingler's Polytechnic Journal" appears twice a month, in two illustrated numbers. The 24 numbers (5 sheets = 80 pages of text each, and more) appearing in the course of a year, and containing about 40 sheets of figures on plates and numerous woodcuts inserted in the text form a complete volume. The Journal may be ordered through any bookseller and in all post offices.

Advertisements find a wide circulation in "Dingler's Polytechnic Journal." (For terms apply at the "Office of J. G. COTTA, at Augsburg, Bavaria.")

SOUTH LONDON CENTRAL PUBLIC LABORATORY.

A Department has been opened for the Private Instruction of Gentlemen in Practical Chemistry as applied to any Special Industries or Commercial Products they may wish to study. For Fees, &c., apply to W. BAXTER, Secretary, Central Public Laboratory, Kennington Cross, S.E.

MR. J. S. MERRY,

ASSAYER AND ANALYTICAL CHEMIST,

SWANSEA.

Wanted, "Watts's Dictionary of Chemistry," with Supplements; also "Roscoe and Schorlemmer's Chemistry."—Address, M. A., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

Wanted, to Purchase Volumes 1, 3, 5, 6, and 7, of the "Journal of the Chemical Society"; also Vol. 3 of the "Proceedings of the Royal Society."—Address, K. P. G., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

TO CHEMISTS, &c.

The Proprietor of Works near London, with waterside frontage, steam power, stills, tanks, and sundry plant, desires to meet with some one who can introduce the manufacture of an article of ready sale and requiring small capital.—Address, in confidence, Q. B., Wool Exchange, Coleman Street, London, E.C.

ON SALE, as a going concern, in one or two lots to suit purchasers, THE CHURCH LANE CHEMICAL WORKS, making Vitriol and Alkali, Dyers' Specialities, &c., &c., belonging to Henry Bury and Company, Limited, and Situate at Church, near Accrington, Lancashire, on the banks of the Leeds and Liverpool Canal, and within half a mile of Church Station (Lancashire and Yorkshire Railway), excellently situated in the centre of the extensive dyeing and printing industries of East Lancashire. For further particulars apply to the Proprietors.

GREENBANK ALKALI WORKS COMPANY (LIMITED), ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{2}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{1}{200}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

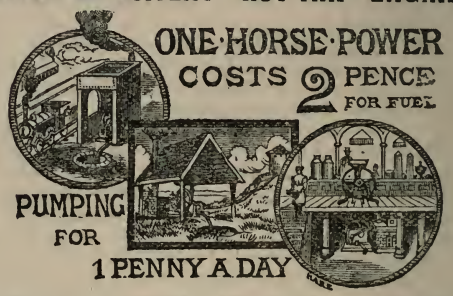
BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application. Orders for small quantities executed for Cash against Invoice.

BAILEY'S PATENT HOT-AIR ENGINE.



Made from ¼ to 5 horse-power. 56lbs. of coke will keep a 1-horse going 12 hours. 1000 galls. of water lifted 50 feet high for a penny.

NO BOILER. NO DANGER.

Awarded Prize Medal by the chief Societies.

SOLE MAKERS—

W. H. BAILEY & Co., Albion Works, Salford, Manchester.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
ULPHITE OF SODA. TANNATE OF SODA.

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

SILICATE OF SODA, Solid and in Solutions of Various Degrees of Concentration: the finest quality obtainable, and especially adapted for the use of Soap Makers and other Consumers.—JOSEPH CROSFIELD and SONS, Soap Makers, &c., Warrington.

London Agent—H. B. CLARKE, Great Tower Street, E.C.

THE CHEMICAL NEWS.

VOL. XLII. No. 1099.

ON THE ESSENTIAL PROPERTIES AND CHEMICAL CHARACTER OF BERYLLIUM (GLUCINUM.)*

By L. F. NILSON and OTTO PETTERSSON.

IN this paper we wish to call attention to some experimental facts which may give a clue to the real nature of beryllium, an element which since the beginning of this century has been the enigma of inorganic chemistry.

The oxide of beryllium was discovered in 1795 by Vauquelin. It was considered a monoxide, BeO, until 1815, when Berzelius† ranged it, principally on account of its basic sulphates, among the sesquioxides. The weighty reasons for this arrangement, never since refuted, which Berzelius added later in the fifth edition of his "Lehrbuch d. Chemie," p. 1225, are too well known to be recorded here.

In 1842 Awdéeff‡ analysed the double sulphates and fluorides of beryllium, which showed qualities not agreeing entirely with the analogous compounds of aluminium, iron, chromium, &c. As the formula of these compounds could be written

$$KO,SO_3+BeO,SO_3,$$
$$KFl+BeFl,$$

this was considered by the chemists of that time to support strongly the old theory. Still the classification of Berzelius prevailed and was confirmed by H. Rose,§ who showed the correspondence of the molecular volumes of Be_2O_3 with Al_2O_3, and also by Ebelmen,‖ who obtained the oxide of beryllium in crystals isomorphous with Al_2O_3. Subsequently an elaborate work, "De Glucium et de ses Composées," 1855, by Debray,¶ once more caused a change in the prevalent opinion.

Debray regarded beryllia as an isolated member of the series occupying a position intermediate between the monoxides and the sesquioxides, and showing marked analogies with both groups, but not intimately connected with either of them by isomorphism. As the analyses of its compounds in most cases agreed better with the simple formula BeO, this was preferable to Be_2O_3.

Klatzo,** in 1868, endeavoured to decide this matter finally by the assumption of a complete isomorphism between the sulphates of Be and Mg, Co, Fe, Ni, and though Marignac,†† in 1873, proved that this pretended isomorphism did not exit, and was founded on a grave mistake, the opinion that beryllia was a monoxide was at this time universally accepted by chemists. Theoretically this opinion was founded on the "periodic law" of Mendeleeff.‡‡ The classification of beryllium at the head of the second group among the diatomic elements is a leading point in the theory of Mendeleeff.

If the composition of beryllia was Be_2O_3, and the atomic weight of beryllium = 13·8, instead of 9·2, the place of Be = 9·2 in the system would be vacant, and the order of the series partially reversed, the "atomic analogies" would be overthrown, and, still worse, beryllium = 13·8 would find no place at all in the system, except in the fifth group among the five-atomic elements, to which it certainly does not belong.

The final decisive proof still wanting to confirm the ideas of Mendeleeff's was furnished, 1877, by Reynolds,* who found the specific heat of metallic beryllium = 0·642, which (Be = 9·2) makes the atomic heat = 5·9, in accordance with the law of Dulong and Petit.

About a year before the publication of Mr. Reynolds, we had succeeded by means of a new method in isolating metallic beryllium from its chloride. We employed† a massive crucible of wrought-iron, hermetically closed by a screw-plug, wherein equivalent quantities of beryllium chloride and metallic sodium were heated to redness. Metallic beryllium was thus obtained, partly fused into globules, partly forming aggregations of little prismatic crystals, which in brightness and colour resembled needles of polished steel. The metal was, as might be expected, not absolutely pure. The analysis was somewhat difficult, the mean result of a number of accordant determinations being :—

Be (metallic)	..	86·94 per cent.
Be_2O_3	9·99	,,
Fe	2·08	,,
SiO_2	0·99	,,
	100·00	

We next determined its specific heat by the method of Bunsen (ice-colorimeter). We here met with quite unexpected difficulties; but, having given up the original arrangement of the experiment described by Bunsen‡ as impracticable, we, by means of an arrangement similar to to that recommended by Schuller and Wartha,§ obtained the following results :‖—

Specific heat of Be = 0·4084 between 0° and 100°.

Atomic heat of Be = 5·64 [Be = 13·8].

These results, not in accordance either with those recently obtained by Mr. Reynolds or the periodic law of Mendeleeff, were not accepted without hesitation by chemists. Notwithstanding that, the editor of the new edition of Gmelin's *Handbuch d. Chemie*, Professor Kraut, altered the formulæ of beryllia and its compounds in the part of the great encyclopædia of chemistry then passing through the press, several other chemists publicly or privately commented on our work, and urged us to pursue our inquiries further. Among the objections thus made we deem the following most worthy of discussion.

Mr. Lothar Meyer¶ hints that the equivalent of beryllium may be wrong, and suggests a revision of that number. If it should be found lower than 4·0 instead of higher, beryllium may still be considered a three-atomic element, without upsetting the periodic law. In that case it would only be necessary to interpose a new group of metals between the trivalent and quadrivalent elements. We had no reason to doubt the accuracy of the old number (= 4·6), which we had found and verified by many analyses, but we redeemed our promise to Mr. Lothar Meyer,** and undertook the following determinations of the atomic weight of beryllium.

In order to determine this value with the utmost accuracy, we thought it safest to choose the simplest possible method viz., the analysis of its sulphate. Originally we also thought of analysing the chloride by titration with silver nitrate, but having found that sublimed beryllium chloride could not be obtained entirely pure, on account of its corrosive action on glass, we gave up the idea.

Sulphate of beryllium is undoubtedly a neutral salt, and is easily obtained in beautiful crystals, which do not

* A Paper read before the Royal Society, Nov. 18th, 1880.

† *Schweigg. Journ. f. Ch. u. Ph.*, xv., p. 296.

‡ *Pogg. Ann.*, lvi., p. 101.

§ *Pogg. Ann.*, lxxiv., p. 429.

‖ *Ann. d. Ch. u. Pharm.*, lxxx., p. 211.

¶ *Ann. de Chimie et de Phys.*, [3], xliv., p. 5.

** "Ueber die Constitution der Beryllerde." Dorpat, 1868. *Journ. f. Prakt. Ch.*, cvi., p. 227.

†† *Ann. de Chim. et de. Phys.*, [4], xxx., p. 45.

‡‡ *Ann. d. Ch. u. Pharm., Suppl.*, viii., p. 151 (1871).

* *Phil. Mag.*, [5], iii., p. 38.

† For the details of the experiment see "Darstellung und Valenz des Berylliums," *Pogg. Ann.*, [2], p. 554 (1878).

‡ *Pogg. Ann.*, cxli., p. 1.

§ *Pogg. Ann.*, [2], ii., p. 359.

‖ *Obs.*—Allowance is made for the impurities of the metal. The specific heat of Be_2O_3 was found = 0·2471 between 0–100° C.

¶ *Ber. d. Deutsch. Chem. Gesellsch.*, xi. p. 576.

** *Ber. d. Deutsch. Chem. Gesellsch.*, xi., p. 906.

Experiment.	Weighed Sulphate.	Loss of Water at 100° C.		Loss of Water and SO_3.		Beryllia.		Equivalent of Beryllium.	
	Grs.	Gr.	Per cent.	Grs.	Per cent.	Gr.	Per cent.	O=8.	O=7·98.
I.	3·8014	0·7696	20·245	3·2627	85·829	0·5387	14·171	4·556	4·544
II.	2·6092	0·5282	20·244	2·2395	85·831	0·3697	14·169	4·552	4·542
III.	4·3072	—	—	3·6973	85·840	0·6099	14·160	4·545	4·533
IV.	3·0091	—	—	2·5825	85·824	0·4266	14·176	4·557	4·550
Mean ..	—	—	—	—	85·831	—	14·169	4·552	4·552

change in the air; but at 100—110° C. it loses half of its water, at 250° it becomes anhydrous, and after heating to light redness pure beryllia remains. Still there is a difficulty in the analysis; for anhydrous sulphate and pure beryllia, as obtained by calcination, are both very hygroscopic substances. We therefore chose the hydrated sulphate, which could be weighed with the greatest accuracy, as the most fitting substance to start with; this salt allowing pulverisation and pressure* without losing a trace of its constituent water. The sulphate was prepared by heating to dryness an aqueous solution of sublimed chloride with an excess of pure sulphuric acid. By repeated crystallisation the sulphate could easily be purified from a slight trace of calcium sulphate, originating from the action of the gaseous chloride on the glass tubes.

The analyses I., II., refer to beryllium sulphate obtained in this manner; for III., IV., the chloride was precipitated with ammonia and the hydrate treated with sulphuric acid. The sulphate was repeatedly crystallised. The difficulty in the analysis is the weighing of the calcined beryllia. For this purpose the crucible, still red-hot, was placed in an exsiccator filled with anhydrous phosphoric acid, and after cooling placed immediately on a scale pan of a Bunge's balance, the equilibrium being beforehand approximately established. In this manner the whole operation required only a few seconds.

By spectroscopical test Professor Thalén has found the beryllia used for these determinations to be absolutely pure.

The hydrated beryllium sulphate has given in the determinations, thus executed, the values shown in Table above.

The equivalent of beryllium has hitherto been determined by—

Berzelius	= 4·9	(analysis of the sulphate).
Awdéeff	= 4·71	" " "
	4·93	(analysis of the chloride).
Weeren	= 4·63	(analysis of the sulphate).
Klatzo	= 4·59	" " "
Debray	= 4·61 — 4·71	(analysis of the oxalate).
Nilson and Pettersson..	= 4·552	(analysis of the sulphate).

All these numbers are higher than 4·0, and consequently the atomic weight of beryllium, if trivalent, must be 13·65, consequently higher than that of carbon. The before-mentioned supposition is consequently proved to be unfounded.

Mr. Lothar Meyer further observes that the atomic heat of the oxygen in beryllia, if a sesquioxide, would be less than in any other oxide known. In the next paper we give the whole series of our determinations of the molecular heats of the rare earths and their sulphates. From this survey, which shows that beryllia, with regard to heat and volume, occupies its proper place at the head of the sesquioxides, we here only extract a few determinations.†

* It was pressed between sheets of fine, porous, bibulous paper, the surface of which had been previously smoothed by heavy pressure.

† Our determinations refer to pure oxides obtained by chemical operations. They are also strictly corresponding and comparable. Other determinations with native alumina (sapphire), made by different methods (Regnault, Neumann), gave a higher number. Determinations by means of the ice-calorimeter always give smaller results, because the standard measure for the heat developed is greater (1 calory = mean of the specific heat of water between 0—100° C.).

If c signifies the specific heat,—

		Atom. heat of oxygen.
In Be_2O_3	$c = 75·32 \cdot 0·2471 = 18·61$	
Be_2	$c = 27·32 \cdot 0·4246 = 11·60$	
	$7·01 = 3.$	2·34
" Al_2O_3	$c = 102·8 \cdot 0·1825 = 18·78$	
Al_2	$c = 54·8 \cdot 0·2143 = 11·74$	
	$7·04 = 3.$	2·35
" Sc_2O_3	$c = 136·0 \cdot 0·1530 = 20·81$	
Sc_2	$c = 88·0 \cdot 0·1454 = 12·80$*	
	$8·01 = 3.$	2·67
" Ga_2O_3	$c = 184 \cdot 0·1062 = 19·54$	
Ga_2	$c = 136 \cdot 0·0802 = 10·91$	
	$8·63 = 3.$	2·88
" In_2O_3	$c = 274·8 \cdot 0·0807 = 22·17$	
In_2	$c = 226·8 \cdot 0·0570 = 12·92$	
	$9·25 = 3.$	3·08

According to the determinations made by us under identical conditions, and therefore strictly comparable, the atomic heat of oxygen in beryllia = Be_2O_3 is the same as that in alumina; this, however, can by no means be considered as exceptional. Alumina and beryllia are the leading members of a group of sesquioxides, wherein the atomic heat and (as will be seen from the following paper) the atomic volume of oxygen increases with increasing values of the atomic weight of metals.

We will now refer to another objection raised to our former researches. Mr. Brauner† admits the specific heat of beryllium to be 0·4084 between 0—100°, but supposes that it may rapidly increase with the temperature in the same way as does the specific heat of C and Bo. If this were the case, he thinks beryllia could be BeO, the atomic heat of beryllium = 3·76 between 0—100°, and normal = 6·4 first at a much higher temperature. In our detailed paper we have tried to meet such an objection, by pointing out that no *metallic* element is as yet known, the atomic heat of which does not agree with the law of Dulong and Petit. However, in order to remove any doubt in this respect, we have determined the specific heat of beryllium at different temperatures lying between 0—300° C. We sifted the metal used in our former determinations through a gauze of platinum, the holes of which were 0·25 sq. millim. For the following experiments we used only that part which did not pass through the gauze, on the supposition that this, consisting of globules and larger crystals, was the purer metal. The analysis confirmed this opinion, for the composition was found to be:—

Beryllium	94·41
Beryllia..	4·89
Iron	0·70
	100·00

* The atomic heat of scandium is supposed to be = 6·4, according to the law of Dulong and Petit.

† *Ber. d. Deutsch. Chem. Gesellsch.*, xi., 1872.

The following tables gives only the results, not the details of our determinations;* the values are referred to p ure beryllium, making allowance for the impurities of b eryllia and iron:—

Temperature.	Specific heat.	Atomic heat.	
o— 46·30° C.	0·3959	5·46	Heating in the vapour of CS_2.
o— 46·30	0·3950		
o— 46·30	0·3980		
o— 46·50	0·4005		
o—100·18	0·4250	5·79	Heating in the vapour of water.
o— 99·97	0·4242		
o—214·0	0·4749	6·48	Heating in the vapour of nitrobenzol.
o—214·0	0·4751		
o—299·5	0·5054	6·90	Heating in the vapour of diphenylamin.
o—299·5	0·5066		

Thus the specific and atomic heat of beryllium increase with the temperature, but a comparison with the same numbers for iron between o—300° C. shows that such an increase of these values is not unusual.

	o—100°.		o—300°.		
	Specific heat.	Atomic heat.	Specific heat.	Atomic heat.	Authority.
Iron	0·1124	6·29	0·1266	7·09	Bède.
Beryllium..	0·4246	5·79	0·5060	6·90	Nilson and Pettersson.

Between o—100° C., the atomic heat of beryllium is equal to that of aluminium = 5·87, and gallium = 5·59 at 214° C. it is normal = 6·48, and at 300° C. it has attained the same value as iron at the same temperature. Beryllium can thus certainly not be compared with the diamond in this respect, the specific heat of which, according to the researches of Weber, being many times higher at o—300° C. than at o—100° C.

Every doubt as to the real atomic weight of beryllium must be removed by the results above mentioned. Fixed at 13·65, according to our determinations, the value of its atomic heat becomes perfectly harmonious with the law of Dulong and Petit.

We will, in conclusion, say a few words upon a paper wherein the results of our former researches have been criticised. In the *Proceedings of the Royal Society*, 1879, Mr. Carnelley applies a new method of calculating the fusion-points of halogen compounds, and applying it to those of beryllium, argues in the following manner:—

Beryllium must be either a dyad or a triad, and must belong either to the second or third group of Mendeleeff's series; if a dyad or Be = 9·2, its chloride, $BeCl_2$, can be calculated to fuse at +547 — +600° C., which is confirmed by experiment; if a triad or Be = 13·8, the chloride, $BeCl_3$ or Be_2Cl_6, ought to fuse about 500 degrees lower, *i.e.*, at +50°— +100° C., which it obviously does not; *ergo*, beryllium is a dyad, and Be = 9·2.

We presume that Mr. Carnelley's knowledge of the physical properties of the triads is, like our own, very limited. With the exception of aluminium, we really know little or nothing of the melting- or boiling-points of chlorides, bromides, and iodides belonging to this group, and we think analogies taken only from one member, aluminium, to be too narrow a base for a calculation which is meant to apply to the whole group. There may be chlorides, bromides, and iodides which do not behave like Al_2Cl_6, in regard to boiling- and fusion-points. We will, in the following paper, give reasons for our opinion that beryllium and aluminium are each leading members of two different groups of trivalent metals. The nearest relatives of beryllium among these are neither calcium and magnesium, with which it has, in fact, little or nothing in common, nor aluminium, with which it has very much more in common, but rather the rare elements, scandium, yttrium, erbium, and ytterbium. We believe that Mr. Carnelley ought to try his calculation on the halogen compounds of the rare elements before asserting "that Nilson's and Pettersson's determination of the specific heat of beryllium must be incorrect." If the properties of the halogen compounds of these elements should be found to agree with the calculation, then we confess that the matter becomes somewhat uncertain, for then one will have to choose between the law of Dulong and Petit and that of Carnelley.*

Our above-mentioned experimental researches, confirmed still more by the experiments, which will be quoted in a second paper, lead us to the conclusion that the real atomic weight of beryllium is = 13·65. But with this value the periodic law cannot admit this element among the metals nearest related, and this fact obviously militates against its general applicability. Before concluding this memoir, we will just point out that this is not an isolated case of its kind. For the element which should take its place beween Sb = 122 and I = 127, the periodic law requires an atomic weight = 125; with regard to its general properties tellurium is quite admissable in this place, but its atomic weight = 128 is too high. Although this number was the result of the determinations of Berzelius and V. Hauer, this want of accordance with the periodic law induced Willis† to make a new determination, but he only confirmed the former results. Thus neither tellurium nor beryllium can be fitted into Mendeleeff's system. And further, after Councler's‡ discovery of the boroxychloride, $BoOCl_3$, boron may be considered as five-atomic, but it certainly cannot be placed among elements of that valence; and when once the chemistry of the rare earth-metals shall be made clear, where can be placed all these elements, the number of which has already become very great and doubtless will be still augmented? Already erbium and ytterbium, with the now fixed atomic weights of 166§ and 173,‖ for the pure metals (the earths = Er_2O_3 and Yb_2O_3), can scarcely be ranged in Mendeleeff's system in places indicated by their relation to the other earth-metals or by their "atomic analogies."

In consequence of what has been indicated here, the periodic law in its present condition cannot be said to be quite an adequate expression for our knowledge of the elements; this theory, however, having given the most striking proofs that the truth in many respects has been found (as for example: the new formulæ for the rare earths = R^2O^3 instead of RO, and the discovery of gallium and scandium, the existence of which the law has foreseen in the elements eka-aluminium and eka-boron), we may expect that the periodic law may be so modified and developed that it can embrace and explain every fact stated by experiment.

* We have also been obliged to determine the increase of the specific heat of beryllia and platinum by higher temperatures in the same way as that of beryllium itself, the metal for the experiments being enclosed in little capsules of platinum foil, hermetically soldered with chemically pure gold. Glass tubes cannot be employed at higher temperatures than 100° for two reasons: 1st, the glass would crack when suddenly cooled to 0°; and 2nd, its specific heat increases very rapidly.

THE DETERMINATION OF SILICON AND TITANIUM IN PIG-IRON AND STEEL.¶

By THOMAS N. DROWN, M.D., and PORTER W. SHIMER, M.E., Layfayette College, Easton, Pa.

In a communication to this Institute at the Baltimore meeting, February, 1879, on the "Determination of Silicon in Pig-iron and Steel,"** the method recommended was the

* *Ber. d. Deutsch. Chem. Gesellsch.*, v. 303.
† *Liebig's Ann. d. Ch.*, ccii., p. 242.
‡ *Ber. d. Deutsch., Chem. Gesellsch.*, xi., p. 1108.
§ According to Cleve.
‖ According to Nilson.
¶ *Transactions of the American Institute of Mining Engineers* vol. viii.
** *Transactions*, vol. vii., p. 346.

treatment of the metal with nitric acid until action had ceased, and then evaporating with sulphuric acid until the nitric acid was nearly or quite driven off. After filtration of the siliceous and carbonaceous residue, and washing with hot water and hydrochloric acid, a silica was obtained, on ignition, which was quite pure. Since this paper was read before the Institute, we have had large experience with the method, and find it uniformly reliable. Results are obtained in a few hours with the greatest accuracy.

While testing the method and comparing it with others in general use, and also with some new methods, there have been developed some facts which may be of sufficient value to lay before the members of the Institute.

Interesting results were obtained by the treatment of iron borings in a platinum crucible with acid potassium sulphate at a red heat. The operation must be conducted with care, to prevent too violent action; but a little practice will enable one to effect the complete oxidation of 1 grm. of iron (the amount usually taken) in from twenty to thirty minutes. On subsequent solution of the fused mass in water, a little hydrochloric acid is added to dissolve any ferric oxide which may adhere to the crucible. For 1 grm. of iron about 25 grms. of the acid potassium sulphate are used. This amount is ordinarily added at once to the iron in the crucible. The operation must, of course, be carefully watched that the mass does not flow over the top. It should not mount higher than three-fourths of the height of the crucible, which should have a capacity of not less than 70 c.c. If the operation has been successful, a nearly white mass will remain in the crucible, without a particle of graphite. The mass may be poured out while liquid; but a more convenient method is to insert into the fluid mass a piece of heavy platinum wire, bent at the end, and then allow the mass to solidify around it. The crucible is then slightly warmed to loosen the contents, which can be lifted out by the wire. The fused mass, with the crucible and lid, is put at once into boiling water with some hydrochloric acid. When solution is complete, the silica is filtered off, and washed with hot dilute hydrochloric acid and water. After drying, the filter, with its contents, is ignited and weighed. The resulting product should be pure white. While accurate results have been obtained by this method in forty-five minutes, yet a long experience with it shows that it is not to be relied on for all kinds of iron and steel. The following are some of the results obtained :—(Table A.)

In the above table will be noticed many results which vary greatly from the true percentage, and for which variation no sufficient explanation is at hand. In general, it may be said that irons high in silica give better results than those low in silicon. With silicon over 1 per cent the tendency is toward too high results; with silicon under 1 per cent the tendency is toward low results. When the silicon is about one-half of 1 per cent or lower, the results are, moreover, very uncertain, as will be seen from the figures for mottled and white iron, also for spiegeleisen and steel. In one experiment on a sample of Bessemer steel (No. 16) no silicon was found, while, in another experiment with the same steel, made by completely driving off the free sulphuric acid from the acid sulphate, and then adding a fresh portion, the percentage of silicon obtained agreed with that by nitric and sulphuric acids. For iron or steel very low in silicon, this last procedure is necessary to get even approximate results; but for ordinary pig-irons it gave no better results than were obtained by simply heating the borings with acid potassium sulphate until all traces of graphite had disappeared. Silver-grey iron is with difficulty oxidised by this method, although the results obtained from one sample were reasonably good.

For Bessemer works, where a rapid method for the determination of silicon is often desirable, this method will perhaps find a useful application. It should be mentioned that we have found great difficulty in buying acid potassium sulphate free from silica or other insoluble matter. In all cases we found it necessary to purify the sulphate by solution in water, filtration, evaporation, and fusion.

Some variations were tried on the method. The pig-iron was first oxidised in the crucible by nitric acid, and the resulting product treated with the acid sulphate. Again, nitre was used in connection with the acid sulphate. In another series of experiments, the iron was heated to redness for some time with sodium carbonate (which has the effect of oxidising energetically the carbon and silicon*), and subsequently treated with sulphuric acid and acid sulphate. These variations were not accompanied with any better results than when the acid sulphate was alone used.

The high results are mostly caused by oxide of iron, which attaches itself in small amount to the upper part of the crucible, and which is somewhat slow of solution in acid. It does not follow that silica which is quite white after ignition is free from iron.

The facility with which pig-iron and steel can be brought into complete solution by fusion with acid potassium sulphate will perhaps recommend this procedure when other ingredients besides silicon are to be determined.

In comparing the silicon results obtained by the nitric and sulphuric acid process with those obtained by the use of hydrochloric acid, we noticed that the results by the latter process were almost invariably higher when the residual silica obtained after burning off the carbon was not re-fused with alkaline carbonates. The same is true when sulphuric acid is used alone without nitric.

In many cases the silica was found to contain iron oxide or other bases, but the higher results were also obtained when the silica was found to be free from metallic oxides. Investigations showed the presence of titanic acid, and an extended series of experiments has shown that titanium is very generally present in pig-iron.

In determining the titanium Riley's method was generally used, which consists in treating the pig-iron with hydrochloric acid and filtering off the siliceous graphitic residue, which is, after ignition, fused with acid potassium sulphate. This method gives fair results; but a more accurate method we found to be the treatment of pig-iron in a porcelain boat in a glass tube with dry chlorine at a red-heat. Pig-iron thus treated is almost completely volatilised, a small carbonaceous residue—5 per cent or less—remaining in the boat. The ferric chloride, with some manganic chloride, condenses in the glass tube (which should be long enough to allow of this), and the non-metals are driven over as gaseous chlorides.

For the absorption of the silicon and titanium a series of three or four tubes or bottles of water is used. No precipitate is noticed in the water, but on boiling titanic acid contaminated with silica is precipitated. To determine the silica and titanic acid, the contents of the bottles are poured into an evaporating-dish and strongly acidified with hydrochloric acid. 15 c.c. of sulphuric acid (sp. gr. 1·23) are added, and the solution evaporated until all the hydrochloric acid is expelled. The silica is thus rendered insoluble, and the titanic acid retained in solution, from which it can be precipitated after dilution by boiling. The results by this method are always a little higher than those obtained by Riley's method. In the treatment of pig-iron by nitric acid and sulphuric acid, the silica obtained is free from titanic acid, which goes entirely into the filtrate. It is not possible, however, to get more than about one-third of the total amount by precipitation by boiling, owing doubtless to the presence of the relatively large amount of iron in solution.

The following table (B) shows the relation between the silicon and titanium in a few pig-irons containing notable quantities of titanium.

Other determinations of titanium in pig-irons by Riley's method are as follows :—

* *Transactions*, vol. vii., p. 146.

Table A.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
Silicon by nitric and sulphuric acids	0·737 0·739	0·772 0·777	1·24 1·25	1·214	2·35 2·37	2·40 2·42	2·40 2·40	0·755 0·757	0·622 0·629
Silicon by fusion with acid potassium sulphate	0·628 0·677	0·772 0·702 0·677	1·41	1·250	2·37	2·53	2·46 2·47 2·47 2·49 2·50 2·50 2·52 2·52 2·54 2·58 2·69	0·749 0·761	0·535 0·566 0·575 0·591

	10.	11.	12.	13.	14.	15.	16.	17.	18.
Silicon by nitric and sulphuric acids	1·92	0·207 0·208 0·210	4·40 4·39	0·165 0·166	0·929	3·75	0·027 0·027	0·682 0·663	0·205 0·027
Silicon by fusion with acid potassium sulphate	1·94 1·94	0·093 0·141 0·231 0·287	4·60	0·116 0·130	0·929	3·94 4·01 4·02 4·19	0·000 0·025	0·529 0·563 0·598 0·628 0·661	0·065 0·115 0·120 0·197 0·209

1. Richmond warm-blast charcoal iron, No. 3. 2. Greenwood cold-blast charcoal, No. 1. 3. Dutchess, anthracite, No. 1. 4. Hecla cold-blast charcoal, No. 2. 5. Bushong, anthracite, No. 1. 6. Leesport, anthracite, No. 1. 7. South Easton, anthracite, No. 1. 8. Glendon, grey forge. 9. Glendon, mottled. 10. Durham, anthracite. 11. White iron. 12. Silver-grey iron. 13. Spiegeleisen. 14. Source unknown. 15. Source unknown. 16. Bessemer steel. 17. Bessemer steel. 18. Sanderson tool-steel.

Table B.

	Glendon grey forge.	Silver-grey.	Source unknown.	Source unknown.	Leesport.	Bushong.
Titanium by Riley's method	0·099	0·114	—	0·318	0·115	0·225
Titanium by chlorine method	—	0·278	0·216	0·374	—	—
* Titanium calculated as silicon	0·077	0·217	0·170	0·291	0·081	0·173
Sum of last with true percentage of silicon	0·832	4·607	1·460	1·751	2·481	2·523
Silicon by HCl method, without re-fusing	0·811 0·815	4·650	1·640	1·840	2·520 2·550	2·590 2·580
True percentage of silicon	0·755	4·390	1·290	1·460	2·400	2·350

* That is, the amount of silicon which would be calculated from the titanic acid mixed with the silica resulting from the hydrochloric acid treatment.

Table C.

Pig-iron treated.	Total percentage of residue in boat.	Siliceous residue after burning off carbon.	Percentage of carbon thus determined.	Silicon determined in this residue.	Silicon from solution in water.	Total silicon by Cl method.	Total silicon by HNO_3 and H_2SO_4 process.
South Easton	3·92	0·292	3·628	0·031	2·335	2·366	2·400
Glendon grey forge	4·17	0·200	3·970	0·022	—	—	0·756
Glendon mottled	4·29	0·302	3·988	0·015	0·444	0·459	0·622
" "	4·15	0·266	3·884	—	—	—	0·622
Source unknown (1)	4·53	0·226	4·304	0·032	0·873	0·905	0·970
" "	4·64	0·277	4·363	0·043	0·908	0·951	—
Source unknown (2)	4·75	0·415	4·335	0·083	1·260	1·343	1·460
" "	4·74	—	—	0·080	1·340	1·420	—
" "	5·22	—	—	0·080	1·330	1·410	—
" "	4·83	0·483	4·497	0·080	1·300	1·380	—
White iron	4·04	0·224	3·816	0·080	0·152	0·232	0·209
Silver-grey	3·38	0·240	3·140	0·045	4·090	4·135	4·400

	Per cent of Titanium.
Richmond, warm-blast, charcoal, No. 3	0·018
Greenwood, cold-blast, charcoal, No. 1	0·052
Hecla, cold-blast, charcoal, No. 2	0·048
Dutchess, anthracite, No. 1	0·055
Leesport, anthracite, No. 1	0·115

A few more details of the treatment of pig-iron with dry chlorine may be worth giving in the accompanying tabular form:—(See Table C.)

It will be seen from the above that the silicon is fairly accounted for in nearly all instances. A more thorough absorption of the silicon chloride by water—or, perhaps still better, by an alkaline solution—may give the full amount of silicon. As far as experiments go, there is no silicon with the condensed ferric chloride in the tube. Phosphorus is present in the ferric chloride, and sulphur is present as sulphuric acid in the water used for absorption, but we have not yet followed up these elements.

When the carbonaceous and siliceous residue in the

boat is treated with water a portion goes into solution, and in this solution may be detected, besides manganese, which we might expect, aluminium, magnesium, and calcium. Whence come these latter metals? Were they present in combination with the iron, or do they simply indicate the presence of cinder in the iron?

In the portion of the residue insoluble in water these elements are likewise found, and it may be that the soluble calcium, magnesium, &c., were present alloyed with the iron, and the insoluble compounds of these metals were in the cinder. More experiments are needed to clear up this doubt.

In an experiment bearing on this point, dry chlorine was passed at a red-heat over cinder which had not been more than twenty-four hours out of the furnace, and it was found to increase in weight about 3 per cent, showing that the absorption of chlorine was not very marked. In a specimen of old cinder the gain in weight under the same conditions was from 16 to 19 per cent. The action seemed to be the conversion of carbonates of the alkaline earths into chlorides.

When dry chlorine is passed over a mixture of a titaniferous ore and charcoal at a low red-heat titanium chloride is volatilised; but when a mixture of a blast-furnace cinder and charcoal is similarly treated no silicon chloride is formed. It is possible, therefore, that the silicon remaining in the boat after the treatment of pig-iron by chlorine may result from the presence of cinder in the iron. More experiments are needed before any decided assertion can be made on this point.

It was expected that the treatment of pig-iron by chlorine at a low red-heat would give a separation of iron from manganese. We were unsuccessful in effecting this separation. In all cases some manganese was found with the ferric chloride. With spiegeleisen or ferro-manganese the fusion of the manganic chloride in the boat rendered it difficult to volatilise all the iron.

In the paper previously alluded to, on the determination of silicon, it was stated that in the treatment of pig-iron by hydrochloric acid about one-third of the silicon was found in solution and two-thirds in the residue. Further experiments have shown that the relative amounts of silicon in solution and in the residue depend on the strength of the hydrochloric acid. Thus, in an iron containing 0·738 per cent of silicon we found in the insoluble residue, after treating with hydrochloric acid, as follows:—

With acid of sp. gr.	1·20	0·616
,, ,,	1·12	0·440
,, ,,	1·015	0·006

Again, in an iron with 2·36 per cent of silicon we found:—

With acid of sp. gr.	1·20	2·26
,, ,,	1·12	2·05
,, ,,	1·015	0·02

There is no loss of silicon by volatilisation in treating grey or white iron with hydrochloric acid.

MONO-NAPHTHYLAMINES FROM NAPHTHOLS.

Messrs. V. Merz and W. Weith announced some time ago (*vide* Chemical News, vol. xli., p. 294), that on heating β-naphthol with ammoniacal zinc chloride only little primary amine is formed, along with much dinaphthylamine. They now announce at the meeting of the Zürich Chemical Society of November 29th, that next to no dinaphthylamine is formed if α- or β-naphthol is heated to 270° or 280° C. with ammonium acetate and glacial acetic acid, or preferably with a mixture of ammonium chloride and sodium acetate. In this case (as proved by several experiments carried out by their assistant, Mr. Calm) sometimes more than 90 per cent of the theoretically possible quantity of α- or β-naphthyl-acetylamine is formed, thus—

$$\left.\begin{matrix}C_2H_3O\\NH_4\end{matrix}\right\rangle O + \left.\begin{matrix}C_{10}H_7\\H\end{matrix}\right\rangle O = C_2H_3O-N\overset{C_{10}H_7}{=}_{H} + 2H_2O.$$

By heating the acetyl compounds with milk of lime preferably under pressure, the primary amines are set free

The two mono-naphthylamines are also obtained in a very simple manner and in large quantities if the naphthols are heated to 260° C., not with ammoniacal zinc chloride, but with ammoniacal calcium chloride, made from porous calcium chloride. The yield amounted to 70 per cent and upwards; the experiments were carried out by Mr. Benz. Similarly to the compound of calcium chloride with ammonia, that of calcium chloride with aniline also excels by its facility of entering into chemical reactions (*reactions vermögen*).

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Saturday, December 11, 1880.

Prof. W. G. Adams in the Chair.

New members—Mr. W. R. Brown, Mr. T. Wrightson, C.E.

Lieut. L. Darwin, read a paper "*On the Rate of Loss of Light from Phosphorescent Substances.*" His experiments were made at Chatham on Balmain's luminous paint by comparing the intensity of the phosphorescent light with the light of a gas burner; the luminous surface being kept cool by placing ice and water near, as a slight increase of temperature in the surface considerably increases the quantity of light given off in a certain space of time. The supply of light was communicated to the paint from a mirror reflecting sunlight. A table and a curve exhibited to the meeting showed the rate of loss found by Lieut. Darwin. It is independent of the original intensity of the illumination. According to the curve the light diminishes very nearly in proportion to the square of the intensity of the light. In a report on the use of Balmain's paint it had been stated that the phosphorescence became brighter a few minutes after exposure in the dark; but the curve showed this to be an error, due probably to the fact that the eye becomes more sensitive to light after being a few minutes in the dark.

Mr. Pearsall emphasised the advantages of such a light in fiery mines.

Prof. Guthrie enquired if the phosphorescent power grew weaker by time, and Lieut. Darwin instanced a specimen eighty years old to the contrary; but

Mr. W. Crookes stated that in damp air sulphuretted hydrogen was given off, and these luminous substances deteriorated; if sealed in a vacuum they would not. Mr. Crookes remarked that in Balmain's patent it was stated that the phosphorescence died out sooner when exposed to a strong light for a short time than to a weak light for a longer time; but Lieut. Darwin thought this was explained by the slow decrease in the lower part of the curve when the phosphorescence became faint.

Mr. R. J. Lecky mentioned that Evelyn in his diary (1650) describes a phosphorescent powder as "bottling up" sunlight.

Dr. Coffin enquired if short exposure to strong light was equivalent to long exposure to feeble light. Lieut. Darwin thought not.

Dr. C. R. Alder Wright read a full paper on the "*Determination of Chemical Affinity in Terms of Electromotive Force.*" He considered first the value of the B.A. unit of resistance, which from different experimenters might be taken as really 1·005 earth quadrants per second, or not

more than ½ per cent out. Clark's element when carefully prepared was practically correct at 1·457 volts, and it kept constant for three or four months after being made, but deteriorated thenceforth some 3 per cent in about two years. The deterioration was assisted by air, which could not be well excluded by the paraffin cork, as it cracked. If sealed in a Sprengel vacuum the element lasted better. Joule's mechanical equivalent of heat (J) he estimated at 42×10^6, or not over 1 per cent greater than Joule's water value. The chief result of Dr. Wright's researches was the conclusion that the action of a current in electrolysis is to decompose the electrolyte into "nascent" products, which evolve heat in changing into ordinary products of electrolysis. These nascent products may be the ultimate atoms composing the molecules of the ordinary products, and the heat is given out in these atoms coming together to produce molecules, say, of oxygen and hydrogen in the case of water. A number of deductions from this theorem are verified by experiment. One of these is that no gas battery can give a higher E.M.F. than 1·5 volts. A result not before published is that the E.M.F. of a Daniell cell is a function of the current, and is a maximum when the current is indefinitely small. The variation may amount to 10°. Therefore all methods of determining resistance by means of two currents of different strength are inaccurate. The experiments also verified Faraday's law that there is no conduction in an electrolyte without electrolysis.

Prof. Adams enquired if Dr. Wright had seen the letter of Prof. Rowland's assistant to the effect that Dr. Wright's former estimate of the ohm was on the wrong side of unity. He had been too busy to see it.

Prof. Foster thought that the variation of E.M.F. in a cell with the current was to be expected, and was probably due to the slowness of diffusion.

Dr. Wright thought diffusion would account for it.

Dr. Lodge said that there was no way of measuring the resistance of a cell except by employing two currents of different strength, and therefore it was necessary to know the law of variation of E.M.F. with current strength.

Dr. Wright stated that he had found two methods of proceeding with currents of the same strength.

With regard to the deduction of Dr. Wright that no current passes without producing electrolysis, Mr. Walenn enquired if the ordinary law of solution held when there was no evolution of hydrogen, and was answered in the affirmative.

Prof. Guthrie cited the experiments of Mr. C. V. Boys and himself on the conductivity of liquids as an instance of a current passing without electrolysis, or if there was decomposition it was followed by instant recomposition.

Dr. Wright thought there must be electrolysis in Dr. Guthrie's experiments (which were conducted by rotating a glass vessel filled with the liquid between the poles of a magnet, after Arago's experiment), because some two parts of the rotating vessel would be at different potentials, and a current would be set up in the liquid.

The Society then adjourned till after Christmas.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, November 16, 1880.

E. W. Binney, F.R.S., F.G.S., President of the Section, in the Chair.

"*Note on the Presence of Sulphur in Illuminating Gas,*" by Harry Grimshaw, F.C.S.

That crude illuminating gas from coal contains a certain amount of compounds of sulphur is of course a well-known fact. That even the best quality of coal-gas, when purified and made ready for consumption, contains still a certain amount of sulphur compounds is also well, but perhaps not generally, known.

An accidental, somewhat peculiar, but very practical demonstration of this fact recently came under my observation, which I thought might be of some little interest to the Society. On the interior of the glass globe surrounding a gas jet in the hall of my house I had frequently noticed the presence of drops of condensed liquid. The jet being near the outer door, and the globe consequently exposed to a rather cold current of air, I merely considered it to be drops of water formed by the burning hydrogen of the coal-gas, and condensed on the cold surface of the glass. I noticed, however, that when the glass became heated through the turning on of a larger flame, the moisture did not, as it ought according to all reasonable expectation, evaporate. I was curious enough to take down the globe, wipe out a few of the drops on slips of paper, and rinse the rest off with water, which I preserved. Having my suspicions from the rather oily appearance of the drop, I warmed the slips of paper a little, and immediately obtained a very fine reaction for sulphuric acid, by the copious blackening and charring of the paper in those places where the liquid had touched it. I then applied the usual chloride of barium test, and obtained a plentiful precipitate of sulphate of barium from the washings of the globe; thus showing, of course, that the oily drops were literally nothing but tolerably strong oil of vitroil.

The genesis, so to speak, of these drops of sulphuric acid is of course easily explained and pretty well understood. The sulphur of course originally exists in the coal used for gas making, mostly combined with iron as sulphide. In the crude coal-gas it exists as sulphuretted hydrogen (H_2S), bisulphide of carbon (CS_2), and to a small extent as sulphur dioxide (SO_2). The greater portion of these compounds of sulphur are absorbed by the ammonia liquor which condenses from the gas itself in the scrubbers, and by the lime and oxide of iron in the purifiers, through which the gas passes on its way to the gasholder, but nevertheless a sufficient quantity remains in the gas to produce the effect above described, and to also produce a bright but very objectionable green deposit of sulphate of copper on the brass of the gaspipe above the jet I have alluded to.

The presence of the corrosive substances, sulphur dioxide and sulphuric acid, in the products of combustion of coal-gas, has always been known and always acknowledged, and yet but little notice of their effects has been taken. It has been said, "The quantity is so small and is disseminated through such a bulk of other gaseous bodies." It is as well to see what this means. If the amount of sulphur in coal-gas is reduced to 10 grains per 100 cubic feet, it is considered a very pure gas indeed. Manchester gas is supposed to attain to this degree of purity, and is, I believe as a rule, a better gas in this respect than that of many other towns. For my own part I should feel inclined to think that only a small portion of the gas made in this country uniformly reaches this standard. However, say that the gas which I burn in my house contains no more than 10 grains of sulphur per 100 cubic feet. This means 100 grains, or about a quarter of an ounce (about) per 1000 cubic feet. I find that I burn on an average, through five or six jets per evening, 8900 cubic feet per quarter. This contains 890 grains of sulphur, which is equal to 2670 grains of sulphuric acid (H_2SO_4); so that I turn into the atmosphere of my house, mostly into one room, nearly 6 ounces of sulphuric acid in three months. This is 24 ounces, or 1½ pounds per annum. Now if I had been burning the Leeds gas, of the quality which has recently been subjected to a good deal of criticism, and which is stated to contain 40 grains per 100 cubic feet, then I should be subjecting the contents of my house to the action of 1½ lbs. of vitriol per quarter, or 6 lbs. per annum. In many cases, certainly in those cases where the contents of the room are most liable to damage, the above amount of gas, namely that from 5 or 6 lights, is given off into the atmosphere of one room.

Almost all the objects in the upper parts of a room are susceptible to damage by the vapour of sulphuric acid. I

do not take into consideration the presence of sulphur dioxide, for it is almost impossible that this body could escape conversion into sulphuric acid in a very short space of time, in the presence of oxygen, the vapour of water, and heat. Ceilings, cornices, wall-papers, pictures, with their cords or chains, and frames, books, and so on, are all objects which are susceptible to the corrosive action of the vapour of sulphuric acid, and there cannot be much doubt that in a longer or shorter time they will all suffer from the presence of the sulphur in gas where the latter is burned in any quantity. The great danger in the action of sulphuric acid, in these cases, is that it is a cumulative one. Its action will be accumulative in a longer or shorter time under the following conditions respectively, burning the same amount of gas in each case. In a longer time if the ventilation is *very good*, and the walls of the apartment perfectly free from any *dampness*. In a shorter time when these two conditions are unfavourable, especially when the walls or portions of them are not perfectly dry, the presence of moisture naturally favouring the formation of sulphuric acid, and also absorbing it when formed and assisting its action. In such cases I have known a most rapid action upon wall-papers of certain kinds, and on organic materials where in contact with metals, notably brass, both the metal and the organic fibre being rapidly corroded.

Many of the objects in the upper portions of rooms to which I have alluded are replaceable, at some little expense, of course, such as the colouring of ceilings and wall-papers, and we may make up our minds to putting up with their deterioration for the sake of the excellent light and convenience of gas-lighting; but to expose such objects as valuable pictures and books to the extensive action of the products of combustion of coal-gas as we at present consume is most injudicious, and is, there can be little doubt, the cause of a great deal of irreparable injury in many cases. My own opinion is, that now that mineral and other oils for illuminating purposes are so cheap, and lamps for their consumption are so admirably constructed and elegant in design, there is not the slightest reason why valuable collections of pictures and books should be exposed to the sulphurous emanations of coal-gas.

Since writing the above I find by an abstract in the *Journal of the Chemical Society* (1880, vol. ii., p. 836), and also in the Chemical News (vol. xli., p. 64), that a Mr. W. R. Nichols confirms the generally accepted view that the deterioration of library bindings is mainly due to the action of the sulphuric acid from coal-gas, and he finds that Morocco is not so much affected as Russia leather and calf skin, and that ordinary sheep skin is attacked by this body.

Addenda.—For methods of estimating the sulphuric acid formed during the combustion of coal-gas, and proof that sulphuric acid is formed, see Young and others. *Analyst*, vol i., p. 143; vol. ii., pp. 66, 67, 118, 133, 135, 139; and vol. iii., p. 201. For the effect of gas on the books of the libraries of the Athenæum, London, Royal College of Surgeons, Portico Library, Manchester, and Literary Society, Newcastle-on-Tyne, see Dr. Letheby's earlier reports to the London Corporation.

THE AMERICAN CHEMICAL SOCIETY.*

The November meeting was held on Thursday evening, November 4th, at University Building, New York; Dr. A. R. Leeds in the chair. The following papers were read:—

"*Isomorphous Salts and Fractional Crystallisation*," by Lucius Pitkin, School of Mines, Columbia College. This paper was a reply to an objection concerning the chemical nature of the platinum salts described by the author at the meetings of November, 1879, and May, 1880. Mr. Pitkin based his argument upon the invariability of composition which the salts showed under varying conditions, and also on the difference in solubility of the double chloride and the double bromide of platinum and potassium. The solubility of the double chloride has been often determined; the solubility of the double bromide, as found by three experiments, is 1 part in 10 of water at 100° C. In discussing this paper, Dr. Endemann expressed himself as satisfied that the salts were really definite chemical compounds, and withdrew his previous objection. He further stated that he was glad the incidental remarks made by him on a previous occasion had led Mr. Pitkin to prove beyond doubt the existence of real chemical compounds.

"*Upon the Production of Ozone, by Heating Substances containing Oxygen*," by Dr. A. R. Leeds, Steven's Institute. From certain theoretical ideas entertained by Schönbein concerning the state in which the oxygen existed in the bodies experimented upon, the author was led to anticipate that on heating ozone would be evolved, and he included in the number of the substances which contained combined oxygen either partly or wholly in an ozonised condition, the oxides and superoxides of all the noble metals, the superoxides and some acids of the common metals, and a number of the states of oxidation of non-metallic elements. Although these ideas were presumably erroneous, in view of the ready conversion of ozone into ordinary oxygen on the application of heat, yet Scönbein not only thought he had experimentally verified them, but his results have been apparently confirmed by later observers, and have been incorporated as established truths in the excellent "Historisch-Critische Studien über das Ozon," just published by Professor Engler. Dr. Leeds showed that in the case of the peroxides of lead and manganese, the latter both in native and artificial condition, of mercuric and of argentic oxides, the apparent ozone reaction was due both to impurities in the substances employed—and which could not be eliminated by washings, however frequently repeated in the course of preparation,—and to the action of oxygen itself on the tests. The same was found to be true of periodic acid, which Bellucci stated yielded ozone on heating to 130°—135°. The statement of Bellucci, previously made by Crofts, that iodic acid gives off ozone in the act of crystallisation, had already been shown by the author to be incorrect, the apparent ozone reaction disappearing after purification of the acid by repeated crystallisation.

"*On the Action of Hyponitric Anhydride upon Organic Bodies*," by Dr. A. R. Leeds (second paper). The crystalline products formed in toluene after being so treated, and after standing for a number of months, were oxalic acid and a body having the ultimate composition of dioxybenzoic acid, but differing in its characters from the four modifications of dioxybenzoic acid hitherto described. The supernatant oil was orthonitrotoluene, yielding, on distillation with water, benzoic acid in the last portions of the water used, and the residue consisting almost entirely of dinitro-para-cresole. From 250 grms. of toluene so treated, 110 grms. of pure dinitrocresole (Victoria yellow) were obtained, and this easy process of preparing the dyestuff may, perhaps, find its application in the arts. Xylene, similarly treated, gave a crystalline product consisting of oxalic and phthalic acids. The oily portion was paraxnitroxylene, yielding in the last waters used for washing it by distillation an abundant crop of paratoluic acid crystals. From phenol the only product obtained had been picric acid, and from anthracen, anthraquinone, the conversion into these bodies by the action of hyponitric anhydride being readily effected.

"*New Colouring Matters Produced by the Action of Nitroso-dimethylaniline-hydrochlorate on Sulphuretted Phenols*," by Jas. H. Stebbins, jun. If one molecule of the soda salt of beta-naptholsulpho-acid be dissolved in its own weight of glacial acetic acid at a temperature of 110° C. and then treated with a molecule of nitroso-dimethyl-aniline hydrochlorate, the result is, first, a brown

* Communicated by Arthur H. Elliott, F.C.S., Recording Secretary.

syrupy mass, then it turns to a dark brown, and finally there is a large disengagement of gas. This completes the reaction. The dark beetle-green pasty mixture thus formed is heated a short time longer to drive off all excess of acetic acid. It is then dissolved in boiling water and saturated with caustic potash. This throws down a light brown precipitate, which is collected on a filter and dissolved in dilute sulphuric acid. In this acid it dissolves with a fine blue colour, and on evaporation a bronze coloured mass is obtained, which is readily soluble in water, and dyes silk and wool of a blue colour in an acid bath.

"*A Process for Detecting Starch Sugar mixed with Commercial Cane Sugar*," by P. Casamajor. Methylic alcohol of about 1·14 specific gravity (Gay-Lussac's alcoholometer 50°) will dissolve its own weight of cane sugar (including impurities usually present in a straight sugar). It will dissolve a comparatively smaller weight of commercial starch sugar. The quantity is known to be less because the saturated solution of cane sugar is syrupy, while that of the starch sugar is very fluid. The author uses a saturated solution of starch sugar to dissolve a cane sugar suspected of containing starch sugar. After a few minutes the cane sugar, inverted sugar, &c., are dissolved, and the starch sugar, if present, will be seen undissolved in chalky specks. If a weighed sample of sugar is taken, the starch sugar left undissolved may be thrown on a weighted filter, washed rapidly with methylic alcohol of 98·5 per cent (92·5° Gay Lussac's Alcoholometer) dried and weighed.

CORRESPONDENCE.

THE GRAHAM MEDAL.

To the Editor of the Chemical News.

Sir,—Prof. Williamson, Graham's successor in the Chair of Chemistry at University College, London, having kindly complied with the request of the Committee of the Chemical Section of the Philosophical Society of Glasgow, that he should act as adjudicator in the competition for the Graham Medal, the Committee will esteem it a favour if you can find room for an intimation to this effect in the columns of the Chemical News.—I am, &c.,

James G. Dobbie, Secretary.

Chemical Laboratory, University of Glasgow,
December 8, 1880.

BLUE COLOUR OF THE ATMOSPHERE.

To the Editor of the Chemical News.

Sir,—In a note recently presented to the Chemical Society "On the Probable Absorption of Solar Rays by Atmospheric Ozone," I am afraid my views were stated in too concise a manner to ensure their being free from misinterpretation. I am credited, I believe, with having ascribed the colour of blue sky to atmospheric ozone. The sentence which seems to have given rise to this idea stands thus in my manuscript:—"If these determinations be correct, there is as much as 40 times the quantity of ozone in the air as is necessary to produce a blue colour, in which case it follows that the blue tint of the atmosphere must certainly be due to some extent to ozone, at times if not always." What I had in mind was, that the blue tint of distant objects when the proportion of ozone was at its maximum, would *in part* be caused by being viewed through a blue medium, which at other times would vary in depth of tint or be entirely absent, according to the meteorological conditions which cause variations in the quantities of ozone. I was led to this remark by having frequently observed that the colour of blue distance changes greatly, being not only sometimes deeper in tint but also occasionally more transparent than usual. The chief portion of my paper dealt with the ultra-violet rays and the improbability of the ammonia carbon dioxide, oxides of nitrogen, or water vapour causing the absorption seen in photographs of the ultra-violet spectrum.—I am, &c.,

W. N. Hartley.

Royal College of Science for Ireland,
Stephen's-green, Dublin, Dec. 14, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 20, November 15, 1880.

Presence of Phosphorus in the Rocks of Bretagne—M. G. Lechartier.—Phosphoric acid is very generally present in the granites and schists of Bretagne.

Composition of the Petroleum of the Caucasus.—MM. P. Schützenberger and N. Tonine.—All portions of this petroleum contain saturated carbides of the formula $C_n H_{2n}$, which the authors name paraffenes. At a bright red heat they yield benzinic carbides, C_nH_{2n-6}, naphthalin and a little anthracen. At dull redness the products are along with unaltered paraffenes, products which unite energetically with bromine, and which are converted into resinous polymers of ordinary sulphuric acid. It is difficult to isolate by means of fractional distillation definite products with constant boiling-points.

Zeitschrift für Analytische Chemie. Part 2, 1880.

Removal of Large Quantities of Sodium and Potassium Chlorides in Mineral Analyses.—Dr. Fr. Muck.—The author remarks that these chlorides often accumulate to a serious extent and prove very inconvenient. He evaporates the filtrates containing magnesia (whether before or after the precipitation of the lime) almost to dryness, covers the residue with cold, fuming hydrochloric acid, stirs well, waits a few minutes, decants repeatedly through a filter formed of glass beads and cotton, and finally washes the saline mass upon the filter completely with strong hydrochloric acid. The residue obtained after evaporating the filtrate contains, in addition to magnesium chloride, very little fixed chlorides, and requires for its solution but a very small quantity of water. The use of glass beads containing lead must be carefully avoided, and also "glass wool," which apparently cannot be procured uncontaminated with lead.

Determination of Assimilable Phosphoric Acid by Dr. Petermann's Process.—Dr. Brunner.—A summary of the principal points in Dr. Petermann's method, the so-called Belgian commercial process. The ammonium citrate is prepared by dissolving citric acid in ammonia, so that the liquid may have a decided but not too powerful ammoniacal reaction. It is diluted to sp. gr. 1·09, filtered, and preserved in well-stoppered bottles. The quantity of the sample operated upon may be—of mixed manures, ammoniacal superphosphates, &c., 10 grms., superphosphates 5, and precipitated phosphates 2. 100 c.c. of the citrate are put in a small washing-bottle, and the weighed quantity of manure is washed with a slight stream into a small porcelain mortar; it is lightly rubbed up with the pestle, and gradually elutriated into a 500-c.c. flask, rinsing with the washing-bottle till the 100 c.c. are consumed. As little water as possible should be used in addition. The flask and its contents are next heated to 35° in the water-bath for exactly an hour, with occasional shaking; then filled up to the mark, mixed by

repeated inversion, and filtered. The liquid which first passes is always turbid, and only the subsequent portion, when perfectly bright, should be taken for analysis. 50 or 100 c.c. of the clear filtrate are then precipitated with a sufficient quantity of magnesium chloride solution, well stirred, made strongly ammoniacal, and filtered after standing for six hours. After washing with ammonia, the precipitate is ignited in the usual manner, and weighed as magnesium pyrophosphate. If the quantity of phosphoric acid soluble in water is required it must be determined in a fresh portion. It is remarkable that in the analysis of certain very rich superphosphates the total phosphoric acid as determined gravimetrically by the molybdenum process was repeatedly found lower than the assimilable phosphoric acid.

Reverted Phosphoric Acid.—Dr. C. F. Meyer.—Already published.

Volumetric Determination of Phosphoric Acid in Crude Phosphates and Superphosphates by Means of Uranium in Presence of Ferric Oxide.—Carl Mohr.—The author proposes the following process:—2 or 5 grms. of the finely-powdered mineral are repeatedly boiled with small quantities of dilute nitric acid; the liquids are mixed in a measuring flask containing 100 or 250 c.c., and when cold filled up to the mark. In case of superphosphate similar proportions are observed, but distilled water is used instead of nitric acid. 10 or 25 c.c. of the filtrate are mixed with a solution of sodium acetate till a permanent turbidity is produced. The solution of uranium acetate is then allowed to flow in, heating gently at first, and afterwards to a boil, and before the precipitation is at an end a few granules of potassium ferrocyanide are added. The ferric phosphate is decomposed, the phosphoric acid enters into solution, the ferric oxide becomes Prussian blue and mixes with the uranium phosphate. The complete transformation of the ferric oxide into Prussian blue is ascertained when a drop of the clear liquid upon a porcelain plate shows no further colouration with ferrocyanide. The hot liquid very rapidly deposits the suspended precipitate. The author presses the rounded end of a moist thin glass rod upon ferrocyanide in a dry powder, when so much clings to the glass as to be sufficient for 10 c.c. of a mineral containing a slight amount of iron. It is important to defer the further addition of the uranium solution till all the ferric oxide is transformed. The addition of the uranium solution is then continued till the known colouration with potassium ferrocyanide indicates the end of the process. The first drop of uranium solution should not occasion a red colouration where it falls. If this happens, a new portion must be taken, and the operation repeated. As in the ordinary process of titrating phosphoric acid with uranium, the solution is rarely absolutely free from iron, the final reaction disappears after it has been already produced—a circumstance which often leaves the analyst in doubt to the extent of entire c.c. This disappearance of the final reaction may be avoided by the careful application of the method described above.

Volumetric Determination of Red-Lead.—Friedrich Lux.—The author places 2·07 grms. of the sample in a porcelain dish holding about 300 c.c., and adds 20 to 30 c.c. dilute nitric acid, heating gently, and stirring. In a few minutes the red-lead is resolved into lead oxide, which dissolves, and peroxide, which is insoluble. He then adds 50 c.c. of a one-fifth normal solution of oxalic acid, and heats to a boil. The peroxide is decomposed and dissolved, and the nature of the liquid shows to a certain extent the quality of the sample. Heavy spar, lead sulphate, clay, iron oxide, and gypsum in large quantities appear as a turbidity or a sediment, whilst if the red-lead is pure a perfectly clear and colourless solution is obtained. The liquid is kept at a boil and the excess of oxalic acid is determined with one-fifth normal permanganate, accurately standardised with solution of oxalic acid. The number of c.c. of permanganate consumed is deducted from 50, and the difference shows the percentage of lead present as peroxide. As not more than 30·21 per cent of lead can be present as peroxide, and consequently 19·79 c.c. of solution of oxalic acid must remain undecomposed, 5 to 10 c.c. of permanganate are added at once, and are immediately decolourised. Towards the end the decolourisation is slower, and the operation may be regarded as complete when the rose colour produced by 2 drops of permanganate does not disappear in half a minute. After the liquid has been rendered colourless by boiling for a few minutes, it is nearly neutralised with ammonia, mixed with a sufficient quantity of ammonium acetate, and titrated in the usual manner with solution of bichromate, 14·761 grms. per litre. The number of c.c. consumed gives the total percentage of lead. If the quantity of lead present as peroxide is deducted from the total, the lead existing as oxide is found, and the composition of the sample is known.

Direct Determination of Soda in Potash.—Dr. A. van Hasselt.

Estimation of Butter.—L. Medicus and S. Scherer.—The authors pronounce the method proposed by Reichert for the analysis of butter to be the most correct in principle, and they apply it in determining whether the composition of butter is unaffected by melting and subsequent congelation. They find that those portions of the mass which are the last to cool retain the largest proportion of the volatile fats. Thus an average sample of butter, 2·5 grms., required for saponification 14 c.c. decinormal soda. The bulk was then melted, allowed to cool spontaneously, and different parts of the mass were analysed. The upper layer required 13·3 c.c.; the bottom, 14·2; the sides, 14·4, and the middle, 17·3. The authors point out the necessity of great care in sampling butters and fats for analysis. In conclusion they give a table showing the quantity of decinormal soda consumed by 2·5 grms. butter as compared with other fats and oils:—Butter, 14 c.c.; lard, 0·2; turnip-seed oil, 0·3; rape oil, 0·4; oil of sesame, 0·35; olive oil, 0·3, and palm oil, 0·5.

Simple Apparatus for Extraction.—L. Medicus.—This paper cannot be intelligibly extracted without the accompanying illustrations.

How Long can Phosphorus be Detected in Cases of Poisoning?—L. Medicus.—In the case of a hen poisoned with phosphorus the digestive organs were found luminous on the twenty-third day after death, and phosphorus was readily detected.

Rapid Detection of Aloes in Elixirs, Liqueurs, and Beer.—Hugo Bornträger.—The liquid in question is well shaken with twice its volume of benzine, and the behaviour of the latter with ammonia is observed. If no red colouration is perceived aloes is either entirely absent or present in quite insignificant quantities.

Analysis of Certain Beers.—E. Schrader.—The beers in question are produced in various places in north-eastern Prussia. Their highest percentage of alcohol is 4·480.

New Gas Blast-Lamp.—Julius Schober.—This paper requires the accompanying woodcut.

Reports on the Progress of Analytical Chemistry. I. General Analytical Methods, Operations, Apparatus, and Reagents.—W. Fresenius.

Application of Sulphuretted Hydrogen in the Dry Way.—From the *Comptes Rendus*, 89, 167.

Determination of High Melting-points.—T. Carnelley.—From the *Journal of the Chemical Society*, 16, p. 365.

Determination of High Boiling-points.—T. Carnelley and W. Carleton Williams.—From the *Journal of the Chem. Soc.*, 1878, 281.

Gas Analysis.—Dr. Clemens Winkler.—Notice of an independent work, apparently of a very valuable character.

Stathmetometric Method of Chemical Analysis.—H. Hager.—Already noticed.

Tables on the Expansion of Water by Heat.—P. Casamajor.—See CHEMICAL NEWS, xxxv., 160, and xxxviii., 137.

The remaining papers in this section are taken from the *Berichte der Deutsch. Chem. Gesell.*, the CHEMICAL NEWS, &c.

II. Chemical Analysis of Inorganic Bodies.—H. Fresenius.

Volumetric Determination of Cerium.—E. Stolba.—Already noticed.

Separation of Cobalt and Nickel.—Ph. Dirvell.—From the *Comptes Rendus*, 89, 903.

Detection of Small Quantities of Mercury.—E. Teubner.—A modification of Eschka's process. The mercury is condensed upon a gold capsule. The peculiar arrangement of the apparatus is shown in an accompanying figure.

The remaining notes under this section are abstracts from the *Annalen der Chemie, Journ. f. Prakt. Chemie*, &c.

The same remark applies to the section on the analysis of organic matter.

Determination of Water in Milk.—H. Geissler.—The method depends on the use of an instrument patented by the author and here figured.

Analysis of Wine.—The methods here summarised have been noticed.

An Improved Microscope for the Examination of Meat.—E. Schmidt and Haensch.—The instrument is described and figured.

Testing Butter.—Compiled from the *Comptes Rendus*, the *Analyst*, the *Pharm. Central-Halle*, &c. In order to distinguish genuine butter from so-called "oleo-margarine," Hager saturates a cotton-wick with the melted sample, lights, and allows it to burn for two minutes, and judges its quality by the smell. Artificial butter gives the well-known offensive odour of an extinguished tallow candle.

Determination of the Specific Gravity of Solid Fats, Paraffin, &c.—H. Hager.—Globular drops of the fats are caused to float in a liquid which consists according to circumstances of alcohol, water, or glycerin.

Adulteration of Bees'-Wax.—See *Pharm. Central-Halle, Corr.-Blatt des Vereins Analyt. Chemiker*, 2, 57.

Analysis of Superphosphates.—See *Berichte der Deutsch. Chem. Gesellsch.*, 9, 1809, *Annalen der Chemie*, 198, 290.

Examination of Quinine Sulphate and Muriate.—O. Hesse.—See *Arch. d. Pharm.*, 213, 490.

For analytical methods referring to physiological and pathological chemistry we must refer to the original.

Forensic Chemistry.

Poisonous Alkaloids from Putrescent Albumen.—F. Selmi.—Already noticed.

Preparation of Sulphuretted Hydrogen for Chemico-Legal Purposes.—The author refers with approval to Otto's method of obtaining sulphuretted hydrogen from calcium sulphide.

Recognition of Human and Animal Blood.—H. Schmidt.—The author steeps the blood for twenty-four hours in potassa-ley at 30 per cent and measures the corpuscles. Those from the blood of the dog are always smaller than from human blood.

MISCELLANEOUS.

The Midland Railway Company.—We are informed that there were considerably more than 100 applicants for the appointment of Chemist to the Midland Railway Company, recently vacant through the decease of the late Mr. S. Bacon. Mr. Leonard Archbutt, formerly a pupil, and till lately chief assistant of Mr. A. H. Allen, is the successful candidate.

South London School of Pharmacy.—The Medals and Certificates for the First B. Course were presented to the following successful competitors on Saturday, December 11, 1880:—Senior Chemistry—Medal, Mr. Preston. Junior Chemistry—Medal, Mr. Cracknell; Certificate, Messrs. Llewellyn and Haines (equal). Botany—Medal, Mr. Fisher; Certificate, Mr. Fry. Materia Medica—Medal, Mr. Llewellyn; Certificate, Mr. Cracknell. Pharmacy and Practical Dispensing—Medal, Mr. Haines; Certificate, Mr. Fisher.

On Technical Museums and Libraries.—At a meeting of the Manchester Scientific and Mechanical Society, held on November 19th, Mr. Alderman W. H. Bailey read a paper on the value of free museums and libraries to the manufacturing interest of the country. He reminded his hearers that prior to the invention of the steam-engine it would be difficult to name any great industry in which we were superior to other nations, and that now this source of power was no longer confined to any one people, only those who can use the forces of nature with the highest wisdom will be first in the race. He remarked that our great inventors at the commencement of this century were nearly all men of ancestral, *i.e.*, hereditary, power, and not having much to do—or as we should express it, not being over-worked and worried—they made great discoveries. Speaking of Richard Roberts, who invented a marvellous number of tools and machinery, he said that this man never tried to do anything at all without first informing himself of all that had been done before. In order to give inventors, especially among the working-class, the means of gaining such knowledge, libraries and museums of models, &c., were needed. He contended that both the museum and the library in every town should be specially adapted to the trade of the district. He referred in terms of warm approval to a catalogue drawn up by Mr. Folkard, of the Wigan Free Library, showing all the works relating to mining and manufacturing, and indexing the transactions of learned societies contained in the library as far as the industries of the district are concerned. It is scarcely needful to add that, *mutatis mutandis*, all these views hold good for the chemical as well as for the mechanical arts.

MEETINGS FOR THE WEEK.

MONDAY, 20th.—Medical, 8.30.
—— London Institution, 5.
TUESDAY, 21st.—Civil Engineers, 8. (Anniversary.)
THURSDAY, 23rd.—London Institution, 7.

TO CORRESPONDENTS.

W. M. Paterson.—The publisher is David Louis Wolff, Magdeburg.

F. N. Harvey.—1. Prof. Wiley's papers will probably be published in some American journal of chemistry. 2. It is only published in German.

THE CHEMICAL NEWS
AND
JOURNAL OF PHYSICAL SCIENCE.

Edited by WILLIAM CROOKES, F.R.S.

Published every Friday. Price 4d. Annual Subscription, post free including Indices, £1

CHARGES FOR ADVERTISEMENTS.

	£	s.	d.
Five lines in column (about 10 words to line)	0	3	6
Each additional line	0	0	6
Whole column	1	15	0
Whole page	3	0	0

A reduction made for a series of insertions.

Cheques and Post-Office Orders, crossed "London and County Bank," payable to the order of William Crookes.

BOY COURT, LUDGATE HILL LONDON, E.C.

PROSPECTUS.

DINGLER'S POLYTECHNIC JOURNAL.

(DINGLER'S POLYTECHNISCHES JOURNAL.)

A Scientific Review of Useful Knowledge in Natural Philosophy, Chemistry, Pharmacy, Mechanics, as well as in all kinds of Manufactures, Arts, Trades, &c.

EDITED BY

JOHANN ZEMAN and Dr. FERD. FISCHER.

PUBLISHED BY

J. G. COTTA, Publisher at Stuttgart and Augsburg.

62nd Year. Terms of Subscription: One year, 36 mark (£1 16s.) Three months, 9 mark (9s.)

We think it advisable, in the interest of the public, to point out the aim which the editors of "Dingler's Polytechnic Journal" have always had in view, and the importance of which is shown by the large number of readers this Journal has found among men of science, manufacturers, engineers, &c. Our aim is to give a *complete* and *exhaustive review* of all remarkable facts in the wide field of applied natural sciences.

A *complete* review, inasmuch as our journal, by means of special articles and reports, will not only treat of every new scientific fact in *Germany*, but will also make its readers acquainted with the industrial progress achieved by *foreign countries*, and this through our special correspondents as well as by profiting of foreign publications.

An *exhaustive* review we mean to give in this sense, that we will not be satisfied with simply illustrating and describing our subject matter, but *thoroughly explaining* the same from a theoretical and practical point of view.

Edited in such a manner, "Dingler's Polytechnic Journal" since its foundation in 1820 has always been increasing in importance and public favour, so that it can bear comparison with the principal scientific journals even of countries that occupy the first rank with regard to their industrial development; as to the richness and variety of its information, it is unrivalled.

The *lists of names* of these volumes contain, for the years 1875, 1876, 1877, 1878, and 1879, respectively 925, 950, 1300, 1600, and 1950 names of authors and inventors mentioned in the text of the Journal.

The *index*, in which every article or communication is mentioned under all its reference-words, contain from 2500 to 3000 titles.

"Dingler's Polytechnic Journal" appears twice a month, in two illustrated numbers. The 24 numbers (5 sheets = 80 pages of text each, and more) appearing in the course of a year, and containing about 40 sheets of figures on plates and numerous woodcuts inserted in the text form a complete volume. The Journal may be ordered through any bookseller and in all post offices.

Advertisements find a wide circulation in "Dingler's Polytechnic Journal." (For terms apply at the "Office of J. G. COTTA, at Augsburg, Bavaria.")

Wanted, to Purchase Volumes 1, 3, 5, 6, and 7, of the "Journal of the Chemical Society"; also Vol. 3 of the "Proceedings of the Royal Society."—Address, K. P. G., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

MR. J. S. MERRY,

ASSAYER AND ANALYTICAL CHEMIST,

SWANSEA.

BETHESDA MINERAL SPRING,

WAUKESHA, WISCONSIN, U.S.A.

Invaluable in Diabetes, Bright's Disease, Urinary Diseases Dyspepsia. A Mild Aperient. Sold by all Chemists and Mineral Water Agents. Agents wanted.

For special terms and further information apply to CEARNS and BROWN, 32, Chapel Street, Liverpool.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m. daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

SILICATE OF SODA, Solid and in Solutions of Various Degrees of Concentration: the finest quality obtainable, and especially adapted for the use of Soap Makers and other Consumers.—JOSEPH CROSFIELD and SONS, Soap Makers, &c., Warrington.

London Agent—H. B. CLARKE, Great Tower Street, E.C.

GREENBANK ALKALI WORKS COMPANY (LIMITED),

ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{1}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

Carr's Patent Paint and Drug Mill.

Approved by some of the most eminent Chemists, and awarded the Silver Prize Medals of the Manchester and Liverpool, and the Middleton Agricultural Shows.

From Messrs. E. H. SMYTH & Co., 21, Duke Street, Edinburgh, and 69, Coleman Street, City, London.—The small Levigator Mill we recently got from you works most efficiently, and is a great economiser of time.

The chief feature in this machine is, that although it can be turned with ease by a boy, it has immense frictional power for levigating purposes. This is caused by the runner being driven at a much greater speed, but in the same direction, than the bowl. The surfaces being Minton ware, they are clean, smooth, and durable.

Testimonials on application.

£11 nett cash, delivered in Manchester.

The diameter of the bowl is 18 ins., and it and the runners are made of Minton ware. It is useful for Painters, Chemists, Grocers, and Cooks, for triturating and mixing Medicines, Vegetable Powders, Ointments, Paints, Sugar, Salt, Spices, Herbs, Meat for Potting, and will grind the COARSEST EMERY INTO A NEARLY IMPALPABLE POWDER in a few seconds. The pan can be tilted for emptying, as shown in the dotted lines; it can be worked by hand or power.

SOLE MAKERS—

W. H. BAILEY & Co., Albion Works, Salford, Manchester

BISULPHITE OF LIME.
BISULPHITE OF SODA.
ULPHITE OF SODA. TANNATE OF SODA.

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

THE CHEMICAL NEWS.

Vol. XLII. No. 1100.

ON HEAT CONDUCTION IN HIGHLY RAREFIED AIR.*

By WILLIAM CROOKES, F.R.S.

The transfer of heat across air of different densities has been examined by various experimentalists, the general result being that heat conduction is almost independent of pressure. Winkelmann (*Pogg. Ann*,, 1875, 76) measured the velocity of cooling of a thermometer in a vessel filled with the gas to be examined. The difficulty of these experiments lies in the circumstance that the cooling is caused not only by the conduction of the gas which surrounds the cooling body, but that also the currents of the gas and, above all, radiation play an important part. Winkelmann eliminated the action of currents by altering the pressure of the gas between 760 and 1 millim. (with decreasing pressure the action of gas currents becomes less); and he obtained data for eliminating the action of radiation by varying the dimensions of the outer vessel. He found that, whereas a lowering of the pressure from 760 to 91·4 millims. there was a change of only 1·4 per cent in the value for the velocity of cooling, on further diminution of the pressure to 4·7 millims. there was a further decrease of 11 per cent, and this decrease continued when the pressure was further lowered to 1·92 millim.

About the same time Kundt and Warburg (*Pogg. Ann.*, 1874, 5) carried out similar experiments, increasing the exhaustion to much higher points, but without giving measurements of the pressure below 1 millim. They enclosed a thermometer in a glass bulb connected with a mercury pump, and heated it to a higher temperature than the highest point at which observations were to be taken; then left it to itself, and noted the time it took to fall through a certain number of degrees. They found that between 10 millims. and 1 millim. the time of cooling from 60° to 20° was independent of the pressure; on the contrary, at 150 millims. pressure the rate was one-and-a-half times as great as at 750 millims. Many precautions were taken to secure accuracy, but no measurements of higher exhaustions being given the results lack quantitative value.

It appears, therefore, that a thermometer cools slower in a so-called vacuum than in air of atmospheric pressure. In dense air convection currents have a considerable share in the action, but the law of cooling in vacua so high that we may neglect convection has not to my knowledge been determined. Some years ago Professor Stokes suggested to me to examine this point, but finding that Kundt and Warburg were working in the same direction it was not thought worth going over the same ground, and the experiments were only tried up to a certain point, and then set aside. The data which these experiments would have given are now required for the discussion of some results on the viscosity of gases, which I hope to lay before the Society in the course of a few weeks; I have therefore completed them so as to embody the results in the form of a short paper.

An accurate thermometer with pretty open scale was enclosed in a 1½ inch glass globe, the bulb of the thermometer being in the centre, and the stem being enclosed in the tube leading from the glass globe to the pump.

Experiments were tried in two ways:—

I. The glass globe (at the various exhaustions) was immersed in nearly boiling water, and when the temperature was stationary it was taken out, wiped dry, and allowed to cool in the air, the number of seconds occupied for each sink of 5° being noted.

II. The globe was first brought to a uniform temperature in a vessel of water at 25°, and was then suddenly plunged into a large vessel of water at 65°. The bulk of hot water was such that the temperature remained sensibly the same during the continuance of each experiment. The number of seconds required for the thermometer to rise from 25° to 50° was registered as in the first case.

It was found that the second form of experiment gave the most uniform results; the method by cooling being less accurate, owing to currents of air in the room, &c.

The results are embodied in the following Table:—

(Rate of Heating from 25° to 50°.)

Table I.

Pressure.	Temperature.	Seconds occupied in rising each 5°.	Total number of seconds occupied.
760 millims.	25°	0	0
	25 to 30	15	15
	30 to 35	18	33
	35 to 40	22	55
	40 to 45	27	82
	45 to 50	39	121
1 millim.	25°	0	0
	25 to 30	20	20
	30 to 35	23	43
	35 to 40	25	68
	40 to 45	34	102
	45 to 50	48	150
620 M.*	25°	0	0
	25 to 30	20	20
	30 to 35	23	43
	35 to 40	29	72
	40 to 45	37	109
	45 to 50	53	162
117 M.	25°	0	0
	25 to 30	23	23
	30 to 35	23	46
	35 to 40	32	78
	40 to 45	44	122
	45 to 50	61	183
59 M.	25°	0	0
	25 to 30	25	25
	30 to 35	30	55
	35 to 40	36	91
	40 to 45	45	136
	45 to 50	67	203
23 M.	25°	0	0
	25 to 30	28	28
	30 to 35	33	61
	35 to 40	41	102
	40 to 45	55	157
	45 to 50	70	227
12 M.	25°	0	0
	25 to 30	30	30
	30 to 35	37	67
	35 to 40	41	108
	40 to 45	58	166
	45 to 50	86	252
5 M.	25°	0	0
	25 to 30	38	38
	30 to 35	43	81
	35 to 40	54	135
	40 to 45	71	206
	45 to 50	116	322
2 M.	25°	0	0
	25 to 30	41	41
	30 to 35	51	92
	35 to 40	65	157
	40 to 45	90	247
	45 to 50	165	412

* Abstract of a Paper read before the Royal Society, Dec. 16, 1880.

* M = millionth of an atmosphere.

There are two ways in which heat can get from the glass globe to the thermometer—(1) By radiation across the intervening space; (2) by communicating an increase of motion to the molecules of the gas, which carry it to the thermometer. It is quite conceivable that a considerable part, especially in the case of heat of low refrangibility, may be transferred by "carriage," as I will call it to distinguish it from convection which is different, and yet that we should not perceive much diminution of transference, and consequently much diminution of rate of rise with increased exhaustion, so long as we work with ordinary exhaustions up to 1 millim. or so. For if, on the one hand, there are fewer molecules impinging on the warm body (which is adverse to the carriage of heat), yet on the other the mean length of path between collisions is increased, so that the augmented motion is carried further. The number of steps by which the temperature passes from the warmer to the cooler body is diminished, and accordingly the value of each step is increased. Hence the increase in the difference of velocity before and after impact may make up for the diminution in the number of molecules impinging. It is therefore conceivable that it may not be till such high exhaustions are reached that the mean length of path between collisions becomes comparable with the diameter of the case, that further exhaustion produces a notable fall in the rate at which heat is conveyed from the case to the thermometer.

The above experiments show that there *is* a notable fall, a reduction of pressure from 5 M. to 2 M. producing twice as much fall in the rate as is obtained by the whole exhaustion from 760 millims. to 1 millim. We may legitimately infer that each additional diminution of a millionth would produce a still greater retardation of cooling, so that in such vacua as exist in planetary space the loss of heat—which in that case would only take place by radiation—would be exceedingly slow.

RECENT HISTORY OF ELECTRIC LIGHTING.

By HENRY MORTON,
President of Stevens Institute of Technology.

On the 17th of October, 1878, in fulfilment of a promise made a year before, the present writer read before the American Association of Gas Engineers an address in which (alluding to the reports then resounding in the daily papers as to Mr. Edison's new form of electric lamp) he said, after quoting an account of a similar report current twenty years before in France:—"These promising experiments, as we all know, reached no successful results. I would by no means, however, have it inferred that better success can never be attained. On the contrary, there are several very promising directions for experiment, on one of which no doubt Mr. Edison is at present embarked; but the difference between a promising line of experiment and a successful result, as all the world's history teaches us, is often a distance of many years, to say the least." An opinion so little calculated as this, to aid in "bearing" gas stocks, naturally excited no little disgust in certain quarters, and I had the pleasure of seeing myself very handsomely abused by those whose approval would have been a very doubtful compliment.

Looking back over the space of two years which has elapsed since those words were uttered, and remembering the events which have transpired in this connection, I feel that I have much more reason to congratulate myself than have those who took an opposite view.

Not only has "the promising line of experiment on which Mr. Edison was then engaged been separated by many years from a successful result," but it has, within this time, been totally abandoned by him for another, which other is, to say the least, still under approval, and the discredit and ridicule which has been cast from all sides has shown how unfortunate and unwise were the reckless and unfounded assertions of the would-be Prophets of the Press.

Notwithstanding these drawbacks, however, continual progress has been made in the development of the art of lighting by electricity, and we have to regret that what would otherwise have been a dignified march of advancing science, reflecting nothing but credit upon this country and its inventors, has been degraded to some extent into a carnival rout of grotesque and absurd extravagances.

In recording the progress which has been made in the art of electric lighting, the most important practical results have been achieved by those who have devoted their attention to the application of the electric arc. The great difficulty which presented itself two years ago in this subject was the unsteadiness of the light, its great liability to extinction, and the actual cost of maintaining it. By improvements in the carbon rods as to their purity of composition and uniformity of structure, a great increase in steadiness has been attained, and by other improvements in the mechanical arrangements of the self-adjusting lamps, this amelioration has been likewise assisted.

Among those who have done most for the improvement of the carbon rods, I would mention Wallace and Sons, of Ansonia, and among the most marked improvements in electric lamps I would cite those of the Brush Co., of Cleveland.

The economical efficiency of the electric generators or dynamo-electric machines has also been increased, and in this regard the best results, so far as accurate tests which have been published indicate, have been obtained by Mr. Edison, whose machine, as tested by Profs. Young and Bracket, shows the very high efficiency of 84·1 per cent of motive force or energy converted into electric current. The machines of other inventors appear to be only a few per cent behind this, if indeed some of them are not found to equal it when accurately measured.

In consequence of these improvements and of the energy with which the several manufacturers have brought these machines to the notice of those likely to use them, their employment in factories, stores, workshops, and hotels has become very general, and has undoubtedly proved of great advantage and convenience, although instances are not wanting (as, for example, in the great cotton mills at Lowell, Mass.), where the electric lighting was abandoned after a thorough test. There is, however, so wide a field in which this light has manifest advantages over any other means of illumination that we may confidently look for a vast increase in its introduction in all parts of the country.

Turning next to the production of light by incandescence we find that this branch of the art also has made marked advances. This art had its beginning as early as 1845, when in the patents taken out in England by King, the representative of the American, Mr. Starr, we find described the use of platinum wires and thin rods of carbon, the latter inclosed in a torricellian, or absolute, vacuum. Extensive experiments in the same line were made by Mr. Moses G. Farmer, the widely known electrician, about the year 1858, and again a little later, by Dr. Isaac Adams, the inventor of the process of nickel plating, now widely used; but the costliness of an electric current derived from a galvanic battery prevented the earlier experimenters from reaching any commercial success, and even with the cheap electricity of to-day, there is still a limit set upon this sort of lighting, by its relatively wasteful expenditure of electric force and consequent costliness.

Great progress has, however, been made here also.

Mr. Edison supposed he had solved the problem two years ago when he had re-invented the earlier methods of Starr, Farmer, and others, but very soon finding, as they had done, the insufficiency of his solution, he attacked the problem afresh with an energy, persistence, and originality of resources worthy of all praise. In the course of his researches he has brought to light a number

of astonishing results, and has discovered whole classes of new properties in platinum, and other metals, and lime, magnesia, zirconia, and other substances.

Had his enthusiastic friends only claimed for him from time to time what he had actually done, his fame would have been unparalleled as a discoverer, and without blemish.

Unfortunately, too many prophecies have been indulged in, and the credit of really great achievements has been overshadowed by the failure of still greater assertions and promises.

After the abandonment of the platinum lamp, Edison next took up the carbon-in-vacuo lamp of Starr, and as before, his friends shouted "Eureka" at the beginning and not at the end of his search.

The carbon lamp, as first made by him, has met the fate of its predecessors, and has been abandoned by him likewise; but from its ashes have arisen, both in his and other hands, improved descendants, which show much better chances of survival.

Having found it practically impossible to make his paper carbons sufficiently durable when heated to such an intensity as would render them even possibly economical as sources of light, he has ransacked nature for some material which would fill these hard conditions, and in a certain variety of bamboo has found something which he believes will yield him a fine hair-like thread of carbon with which he can obtain the light of 16 candles from a single lamp, at an expense of 3400 foot-pounds of energy a minute. This would represent about 9 such lamps, or about 155 candles per horse power.

This is a decided improvement in efficiency over his horse-shoe lamps of last year, and with a durability, as is claimed, of six months, will carry his system a long step forward on the roads toward success.

Starting, also, with the idea of Starr as to the use of a strip of carbon in a vacuum, Mr. Maxim has proceeded along a different road.

In place of searching through nature for a substance which would yield a perfect lamp-carbon on heating, Mr. Maxim has sought to make a perfect carbon strip in his lamp by building it up on any imperfect form as a substratum. To accomplish this he has taken a strip of carbonised paper as his groundwork, and has plated this over with a metallic layer of graphitic carbon, by heating the original carbon strip by a current in an atmosphere of gasoline vapour. Under these circumstances, not only is a sheet-like coating of this peculiar carbon deposited all over the strip, but, if there is a weak spot anywhere in it, the carbon will be first deposited at this point (on account of its getting hotter than the rest), and thus an irregular or defective carbon strip will be repaired and rendered perfectly uniform.

By this process two objects are attained. In the first place a good carbon strip is secured, no matter what imperfections may have existed in the original paper or other carbon foundation. In the second place, the outer surface of the strip is composed of that variety of carbon whose resistance to heat and mechanical injury surpasses all others. All familiar with the material will know, that what is technically called "gas carbon" (*i.e.*, the carbon deposited in the outlet retorts by the decomposition of the issuing gas), of gas is a metal-like substance, the cutting, breaking, or shaping of which is very difficult, on account of its combined hardness and toughness. It very rapidly spoils the best steel files and saws, and to break it with a hammer is almost a hopeless undertaking.

I have also known a weighed quantity of it to be placed with the fuel in a cupola furnace where iron was being melted, and to have been taken out again after some hours not sensibly diminished in weight.

This is the material of which the surfaces of the carbon strips in the Maxim lamps are composed, and should they prove as enduring as is hoped, it is to this that we should naturally credit their resistance.

I have measured a number of these lamps with such results as the following:—

Lamp A.—Resistance cold 20·4 ohms, and when yielding in its best position the light of 50 standard candles its resistance was 8·3 ohms. The current required to heat it to this degree was one of 4·07 webers, and the energy expanded was therefore about 5850 foot-pounds. This would represent about five and a half (5½) such lamps to each horse-power of energy of current employed, or an efficiency of about 275 candles per horse-power. Taking 70 per cent of this as the average for all positions we would have about 192 candles per horse-power of current. Now the amount of actual horse-power in the steam engine required to develop one horse-power in the lamps will vary with the dynamo-electric machine, the number of lamps in use, and many other conditions, but we may assume 60 per cent as a safe allowance and this would give us about 115 candles per actual horse-power from the engine as the efficiency of this lamp when run at 50 candles.

Another lamp (D) whose resistance cold was 115 ohms when yielding a light of 52 candles required a current of 1·35 webers, and had a resistance of 64 ohms when emitting the above-mentioned amount of light.

The electric energy consumed in this case was therefore about 5131 foot-pounds per minute, or about 6·4 such lamps to a horse-power, or at a rate of 330 candles per horse-power of current.

Taking 70 per cent as the average light in all directions, reduces this to 231 candles, and assuming 60 per cent as the efficiency of the conversion from steam power into electric current in the lamp, brings it to 138 candles per horse-power of mechanical force developed in the steam engine.

We see therefore in this case also a marked advance upon the state of the art a year ago.

Undoubtedly the advance now made is sufficiently encouraging to authorise the experiments which are being made to apply these lights on a practical scale in locations where they have peculiar advantages, as, for example, in the vaults of the Safe Deposit Co., New York. When that experiment has been carried on for a few months, we shall know much more than we do now as to the actual running cost of the system, but anything like a general adoption of the same in place of gas is still an affair o the future about which prediction is premature.

THE DETECTION OF STARCH AND DEXTRIN.

By SPENCER UMFREVILLE PICKERING, B.A., Oxon.

In conducting some experiments in which it was necessary to ascertain the presence or absence of starch in a liquid containing various amounts of dextrin, the few facts here described were brought to light, and may, perhaps, be of sufficient interest to warrant their publication.

When a solution of starch which has been coloured blue by the addition of iodine is heated, it is found that the temperature at which the colour disappears varies with the intensity which it possessed before heating. Thus, for instance, 100 c.c. of a rather dark iodine-starch solution on being heated gradually in a flask became perfectly colourless at 58° C., and, on being cooled, showed a slight reappearance of colour at 49° C., whereas an opaque blue solution did not lose its colour till heated to 99° C., and became visibly coloured again when cooled to 63° C. Similarly variable results were obtained by experimenting on iodine-starch solutions in sealed tubes, the temperatures of reappearance being much more constant (generally about 50° C.) than those of disappearance; this no doubt is due to the fact that, the stronger solutions having been heated to a higher temperature than the weaker ones in order to effect the disappearance, a greater quantity of the iodine present in them would have been converted into hydriodic acid, and this would tend to an equalisation of the amounts of iodine present on cooling in the various

cases. Owing to this conversion of iodine into hydriodic acid, the solutions on cooling, as might be expected, are considerably lighter than they were before heating, and their intensity naturally depends to a great extent on the rapidity with which they have been cooled; even a very weak iodine-starch solution which has been heated may be made to re-assume its colour if cooled very quickly.

The amount of starch which may be recognised by means of the iodine reaction varies, of course, with the bulk of liquid operated on. Using about 200 c.c. the weakest solution which gives an easily discernible blue tint in a beaker contains about 0·0001 per cent of starch; while if small quantities are examined in a test-tube this percentage must be doubled in order that the colour may be rendered visible. The green colour which is noticed when a large quantity of iodine is added to a weak solution of starch, appears to be due simply to the combination of the proper yellow colour of the free iodine with the blue colour of the iodine-starch.

When two weak solutions of iodine, to one of which some starch has been added, are exposed to the air in an uncovered beaker, the iodine in both cases disappears entirely in the course of a few days, but more slowly from the solution which contains the starch; hence the iodine which disappears (owing partially to its volatilisation into the air and partially to its hydrogenation) seems to be retained to a certain extent by the presence of starch. The presence of iodine has a reciprocal action in the preservation of starch. A solution of starch, which, in a few days, is converted into dextrin, may be preserved unaltered for a long time—possibly for an indefinite time, if an excess of iodine is present in it.

When a sufficient quantity of iodine is added to a solution of dextrin, a deep brown colour is produced; the coloured compound which is here present is in a state of true solution, whereas in the case of starch it will, as is well known, settle entirely to the bottom of the liquid in deep blue flocks, leaving the supernatant solution quite colourless, and these flocks on agitation are disseminated again so as to form an apparent solution. The dextrin reaction with iodine is not nearly so delicate as that of starch; the weakest solution which gave any discernible colour on being tested contained 0·005 per cent of dextrin, and in this case the colour could only be detected by using about 200 c.c. of the solution, and comparing the colour with that of some iodine solution of the same strength as that to which the dextrin had been added.

With starch, the first drop of iodine which is added produces a permanent colouration. With dextrin, however, this is not the case; the colour produced by the first drops disappears instantly and entirely. A considerable quantity must be added before a moderately permanent colour is produced, and the reaction, owing to which the iodine disappears in this way, will continue for six or seven days. Whether the dextrin disappears or not at the same time has not been ascertained, although it seems most probable that it should do so.

When a solution of iodine-dextrin is heated, the colour becomes lighter and gradually disappears, as in the case of iodine-starch, but the temperature at which this disappearance takes place is considerably lower. An opaque brown solution on being heated in a flask became colourless at about 81° C., and, on cooling, regained its colour with considerable diminution in intensity) at 64° C. A solution of one-quarter the strength of the preceding one lost its colour at 52°, and regained it on cooling at 34° C.; here also, as in the case of iodine-starch, we find that the coloured principle does not become colourless at any particular temperature, but its disappearance is dependent on its original intensity.

The dextrin usually met with in commerce contains a considerable amount of starch, which, however, may be entirely converted into dextrin by prolonged heating at 140° to 160° C. for several hours, after which it gives the pure brown reaction with iodine above mentioned.

When iodine is added in excess to a mixture of starch and dextrin, the colours produced are blue, violet, purple, claret, red-brown, or brown, according to the various proportions in which the two substances are present. When the iodine is added gradually to the mixed solutions the colours produced, both temporary and permanent, follow the same order as those above mentioned, the blue colours appearing first, and the red ones only on the addition of larger amounts of iodine. Conversely, when the coloured solution is allowed to stand, the red tints disappear first, and the blue ones last. Obviously, therefore, the gradual addition of iodine affords an easy and delicate means of detecting starch in the presence of even a large amount of dextrin. Another way in which starch may be detected in similar cases, is to add an ample sufficiency of iodine to produce a permanent colour, and then to heat the liquid; the brown iodine-dextrin is decomposed at a comparatively low temperature, while the blue iodine-starch remains till the heat is raised considerably higher, and again, on cooling, the blue tint reappears long before the brown or red tint does: even when there is not sufficient starch to yield satisfactory results by this method, it may often be detected by the liquid being of a more bluish tint after the heating than it was before it.

O. Knab (*Chem. Centr. Blatt*, 1872, 492) found that some dextrin which he had prepared by repeated (ten times) precipitation with alcohol gave the reaction of a mixture of dextrin and starch, and hence concluded that it still contained some of this latter substance. It appears superfluous, however, to raise an impure preparation to the dignity of a chemical compound by giving it a distinct name—dextrin-starch—as Knab does. On leaving a mixture of solutions of starch and dextrin for some days, Knab found that, whereas the addition of iodine had at first caused a deep blue colouration, after a time nothing but the red or brown colour of iodine-dextrin was produced, and hence draws the somewhat startling conclusion that starch under the influence of dextrin is converted into dextrin. A simpler and more probable conclusion from these experiments would surely have been, that at the end of the few days during which his experiments lasted, the starch had suffered that spontaneous decomposition to which it is, as is well known, so prone, leaving in solution nothing which would give a colouration with iodine but the unaltered dextrin.

Dextrin and starch, it appears, give entirely different reactions with iodine; the former combines with the halogen to form a brown soluble substance, whereas the latter forms with it a deep blue insoluble body; and these two reactions are so distinct that presence of either of the reagents may be easily detected in a solution containing both of them.

The fact that the addition of iodine to dextrin produces only a transitory colour at first, and that an excess of it is necessary to give a permanent tint, will, no doubt, explain the various discordant statements which exist as to whether any colour is produced by the mixture of these two substances or not, and will probably render unnecessary the theory of there being two or three different dextrins as proposed by Mulder and by Griessmayer.

Detection of Iodine in Bromine and Metallic Bromides.—A. Jorissen.—A few drops of the bromine in question are placed in a small porcelain capsule, 30 c.c. of a solution of potassium chlorate, saturated in the cold, are added, and the liquid is boiled till colourless. The solution is then poured into a test-tube, allowed to cool, mixed with a few drops of a solution of morphine sulphate and a little chloroform. If the chloroform takes a violet colour, iodine was present in the sample. The morphine solution is prepared by dissolving 0·5 grm. morphine in an excess of dilute sulphuric acid, and diluting to 50 c.c. In examining potassium bromide the solution is mixed with 2 or 3 drops of pure bromine water, and a few c.c. of a cold saturated solution of potassium chlorate, and further treated as above.—*Zeitschrift fur Analytische Chemie.*

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, December 16, 1880.

Prof. H. E. Roscoe, President, in the Chair.

The following certificates were read for the first time:—B. Akroyd, H. Baker, M. M. Bird, H. P. Cooper, H. W. Fenner, T. S. Judson.

The President then called on Mr. Ruffle to read a paper "*On the Estimation of Nitrogen by Combustion, including the Nitro-compounds.*" For strictly correct chemical purposes the nitrogen in a substance is estimated by Dumas's method; in analytical practice the process ueually employed is the well-known soda-lime method of Will and Varrentrapp. It has long been known that with some compounds containing nitrogen this process gives very imperfect results. Thus, sodium nitrate, when burnt with soda-lime, gave an acid instead of an alkaline distillate. It has been proposed to add various substances to the soda-lime to obtain better results. The author has tried the effect of numerous devices of this nature. Mixing with sugar, a current of hydrogen, of olefiant gas, of marsh-gas, tartaric acid, citric acid, benzoic acid, sodium formate, sodium acetate, hydrogen sulphide, ferrous sulphate, sodium sulphide, sodium sulphite, sodium hyposulphite, potassium hyposulphite, barium hyposulphite, barium hydrate instead of lime, mixtures of caustic soda with various reducing substances, sulphur, iron, charcoal, tin, zinc, antimonious sulphide, antimony, arsenic, arsenious acid, sodium hyposulphite: all, however, yielded results much too low or were inconvenient. A mixture of sodium hyposulphite and sodium hydrate yielded theoretical results, but had the great objection that it could not be obtained as a powder, only as a wet mass. After many trials it was found that a mixture containing—

2 molecules of sodium hydrate,
1 molecule of pure lime (from marble),
1 molecule of sodium hyposulphite,

the first two being slaked together, dried, and finely powdered, gave very satisfactory results with all varieties of guano, gunpowder, nitrates of soda, potash, and silver, picric acid, sodium nitro-prusside, East Indian linseed, milk residues, dried flesh, &c. The author uses ½ inch lap-welded steam-piping, bored out to ⅝ inch, in 22 inch lengths, for combustion tubing. The substance is mixed with 1½ grms. of a mixture of equal parts of sulphur and wood-charcoal. 13 grms. of the above soda-lime mixture and 21 grms. of powdered hyposulphite of soda are weighed, and mixed. 5 grms. of this mixture are placed at the back of the combustion-tube, then the mixture containing the substance, then the rest of soda and hyposulphite, and finally 18 grms. of ordinary soda-lime. The combustion is commenced 4 inches from the front end, and continued gradually until the evolution of gas ceases: it is maintained at a red-heat for ten minutes. The average time of a combustion is forty-five minutes. As results may be quoted the following:—

	Theory.	Found.	
Potassium nitrate ..	13·86	13·86	
Silver nitrate	8·23	8·03	
Sodium nitrate.. ..	16·47	16·32	mean of 5 analyses
Picric acid	18·34	17·91	„ 6 „

In answer to Mr. Perkin, the author stated that he had not used the method with any organic nitro-compound other than picric acid; it did not succeed with aniline.

Mr. Warington said we must not too hastily conclude that the soda-lime process does really fail: there were many eminent chemists who contended that when fairly conducted it gave good results. If the temperature was too high the ammonia formed was decomposed again; errors also crept in when air was aspirated through the tube when hot. Care should also be taken to have a good layer of soda-lime in front of the mixture. He did not think that it was quite fair to conclude that the results obtained by the soda-lime process must be wrong because those by Dumas's method were higher. The question was one of very high practical importance in the analysis of manures.

Dr. Voelcker testified to the value of the author's process when mixtures of ammonia salts and nitrates had to be dealt with. He could strongly recommend it. The points to be attended to in the soda-lime process were plenty of soda-lime and complete combustion without too high a temperature.

Mr. Ruffle said that he had carefully attended to the precautions just mentioned in the combustions he had made with soda-lime.

The President then said that Dr. Carnelly had been good enough to promise to show the experiments concerning the effect of pressure on the fusing-point, of which the Fellows present had doubtless heard. The author did not propose to read a paper, as his results were published elsewhere, but only to show the experiments.

Dr. Carnelly then explained the device which he had adopted in order to secure and maintain a vacuum in the case of ice. For the success of the experiment the tension must be below 5 millimetres. The apparatus consisted of a wide glass tube ⅞ inch in diameter, and about 5 to 6 feet high. This is placed in a vertical position, and is connected at its upper end with a strong glass flask placed horizontally, and surrounded with a freezing-mixture. The apparatus having been inverted and filled with mercury, the lower end of the tube is closed with the thumb, and placed under the surface of a layer of mercury about 10 inches deep. On withdrawing the thumb the mercury sinks in the tube to the barometric height, and a large Torricellian vacuum is obtained, which is surrounded, as far as the flask is concerned, with a freezing-mixture. A small quantity of boiled water is now introduced, which rises to the top of the mercurial column, and surrounds the bulb of a thermometer suspended inside the tube. The water is then frozen, and the depth of the layer of mercury in which the tube stands reduced to about 3 ins.; in consequence the mercury in the tube sinks, and leaves a detached column of ice with the thermometer bulb in its centre. This column acts as a cork, shutting off the large vacuous space above from the small vacuum below. By carefully heating the tube the ice is melted round the circumference of the plug, and a fine annular opening is made between the ice and the inside of the glass tube. This restores the communication between the upper and lower portion of the vacuum. As soon as this is effected, any aqueous vapour which is formed is at once condensed by the freezing-mixture, and the vacuum is kept intact. Under these circumstances the author has made the ice so hot that the thermometer in the centre of the cylinder stood at 180° C. before the ice melted. In the experiment shown to the Society the thermometer only rose to 30° C. when the cylinder (which was too large and therefore too heavy) dropped off the thermometer. To prove that the ice was really hot the author has contrived and carried out some experiments, in which the cylinder of hot ice was dropped into a small calorimeter filled with water; the temperature rose when the ice was introduced, whereas if ordinary ice it would of course have been lowered. The author then showed two experiments with camphor and mercuric chloride, which were perfectly successful. The camphor was contained in a glass tube closed at one end and connected at the other with a Sprengel pump. On heating the tube the camphor melted, but on starting the Sprengel pump the camphor, as the pressure decreased, solidified, though the heating was continuous. The mercuric chloride was similarly raised many degrees above its ordinary melting-point, when kept under diminished pressure, without liquefying; but on allowing the atmospheric pressure to enter, by cutting the tube, the solid mass immediately melted and began to boil.

Prof. McLEOD suggested that the cylinder of ice might be used as its own calorimeter on admitting the atmospheric pressure. If the ice were at 180° C. it should liquefy into water at about 100°.

Prof. AYRTON pointed ont that although these results seemed at first sight at variance with the experiments of Sir William Thomson and the well-known calculations of James Thomson, according to which an increase of pressure lowers the melting-point, there was really no direct opposition between them, because the constants on which Carnot and James Thomson based their calculations were only constants at temperatures at and below 32°, and we had no evidence until these experiments of Dr. Carnelly as to the value of these constants at higher temperatures. Under ordinary conditions an increase of pressure produces a slight diminution of the melting-point, yet it was perfectly in accord with the principles of thermodynamics to suppose that at temperatures above 32° a slight diminution of pressure might enormously raise the melting-point.

Mr. T. BROWN said that he did not quite understand how removing the pressure from the outside of the ice could affect the ice in the interior, and it was difficult to see why the ice in the interior should not liquefy if raised to 180°, even if the diminution of pressure prevented the liquefaction of the surface layer.

A vote of thanks to Dr. Carnelly from a crowded meeting was then passed by acclamation.

Dr. ARMSTRONG then read a joint paper "*On Some Naphthalene Derivatives*," by Mr. N. C. GRAHAM and himself. It was a continuation of the authors' former paper, and dealt especially with experiments they have made to establish the law of substitution for β-naphthol. In their previous communication they have shown that Merz and Ebert are correct in regarding the naphthol-sulphonate produced by fusing naphthalene-β-disulphonate with potassium hydroxide as identical with that obtained from β-naphthol, and have pointed out that in this acid the radicles are probably in the relative positions 2 : 3. The action of bromine on the potassium salt of this acid is now described. The product of the action of a single molecular proportion is a highly characteristic bromo-β-naphthol-sulphonate, $C_{10}H_5Br(OH)(SO_3K)$, which crystallises in colourless plates, sparingly soluble in cold water. If two molecular proportions of bromine are employed α-dibromo-sulphonate, $C_{10}H_4Br_2(OH)(SO_3K)$, is formed, which is also colourless, but more soluble and less characteristic in appearance than the mono-bromo-salt. By the action of three or four molecular proportions of bromine, however, coloured salts containing less bromine than those resulting from the employment of a less amount of the halogen are produced. The product of the action of $3Br_2$ is probably a mixture of the products of the action of $2\ Br_2$ and $4Br_2$. The latter crystallises in lustrous deep orange plates, moderately soluble in water, forming a deep red-coloured solution. Potassium and bromine determinations agree with the formula—

$$C_6H_4(O)_2(OBr)(SO_3K),$$

which is that of a potassium bromoxyl-α-naphtha-quinone-sulphonate. Bromine apparently has no action on this salt. Having obtained a quantity of what they presumed to be the dihydroxy-naphthalene of Ebert and Merz, the authors converted it into a sulpho-acid by treatment with twice its weight of bromine. The product, however, was entirely different from that recently described by Griess, being incapable of forming colours with diazo-compounds. On treatment with bromine, nitric acid, &c., it yields a number of highly characteristic bromo-nitro- and bromo-derivatives. The authors were thus led to doubt whether Ebert and Merz are correct in stating that only one of the two naphthalene-disulphonates is convertible into a dihydroxy-naphthalene.

The Society then adjourned to January 20, when a paper "On Some Hydrocarbons Present in Resin Spirit," by H. E. Armstrong, will be read.

PHILOSOPHICAL SOCIETY OF GLASGOW.

CHEMICAL SECTION.

November 16th, 1880.

Mr. J. MACTEAR, F.C.S., F.I.C., President, in the Chair.

FIFTEEN gentlemen were elected, and four were proposed for the first time, as Associates of the Section.

The SECRETARY opened a discussion "On the Action of Sulphuric Acid upon Lead" by reading the following paper communicated by Mr. JAMES NAPIER, jun., "*On the Action of Concentrated Sulphuric Acid on Lead at Ordinary Temperatures.*" About a year ago our firm (James Napier and Co.) shipped a number of lead cases containing concentrated sulphuric acid. These cases were enclosed in wooden boxes bound with hoop-iron—a form of package for exporting acid well known in the trade, and which has been in use for many years. The vessel with these cases on board had been to sea for more than a month when, through stress of weather, it was put back to Greenock for repairs, and we were informed shortly afterwards that the cases of acid we had put on board were being unshipped, and were in a most deplorable condition. On inspection we found that nearly all the lead cases, originally cubical in shape, were now swollen, from internal pressure, almost to a spherical form, and all the wooden boxes were broken and burst asunder. We requested Mr. R. R. Tatlock to investigate the matter for us, and for that purpose he took samples of the gas, the acid, and the lead for analyses, and we also furnished him with cuttings from two lead-pans which had been in use at our works for several months concentrating acid to 146° Twaddell. The following extracts are from Mr. Tatlock's report :—

"The cases were made of sheet-lead of about 7 lbs. to the square foot. They contained each about 2 cwts. of concentrated sulphuric acid, were hermetically sealed by the fusion together of the edges of the lead, and were packed in boxes made of wood ⅛ of an inch thick. It was at once apparent that the lead cases had expanded and bulged to an extraordinary extent, so much so that some of them were approximately spherical, and had forced asunder the wooden boxes in which they were contained. The effect was manifestly due to internal pressure, and on puncturing one of them with a pocket-knife a jet of gas rushed out with great force, and continued for about one minute. A sample of this gas was collected for analysis (sample No. 1); a sample of the acid also taken from the same case (sample No. 2); a sample of lead was also cut off from an empty case, which was said to have exploded on the application of a flame (sample No. 3); and also a sample of lead which seemed to have given way spontaneously (sample No. 4). On the same day I received from Messrs. James Napier and Co. two samples of lead labelled as follows :—'Cut from a pan which has been in constant ush for more than six months, considered a good pan' (sample No. 5); and, 'Cut from a pan still in use, and which has been going about six months: Lang's lead' (sample No. 6). I have made an analysis of each of these samples excepting No. 4, which it was considered quite unnecessary to analyse, with the following results :—

Sample No 1.—Gas from Bulged Case.

This was found on analysis to consist exclusively of pure hydrogen gas.

Sample No 2.—Sulphuric Acid.

Pure sulphuric acid	99·78
Sulphurous acid	0·02
Sulphate of lead	0·13
Sulphate of lime	0·07
	100·00
Specific gravity	1·842
Equal to degs. of Twaddell's hydrometer	168½

Samples Nos. 3, 5, and 6.—Sheet-lead from exploded case, and two samples of lead from Messrs. James Napier and Co.

	No. 3. Per cent.	No. 5. Per cent.	No. 6. Per cent.
Lead	99·9595	99·962	99·503
Copper	0·0370	0·037	0·077
Zinc	absent	absent	absent
Iron	0·0020	0·001	absent
Antimony	absent	absent	0·420
Tin	absent	absent	absent
Silver	0·0035	not estimtd.	not estimtd.
	100·0000	100·000	100·000

In addition to these analyses the following experiment was made.

Measured portions, having equal surfaces, were cut from the three samples of lead, of which the above are analyses, and immersed in good concentrated sulphuric acid. Chemical action immediately took place in the case of every sample, with effervescence, due to disengagement of hydrogen gas. The action soon ceased, however, in the case of Napier's pan lead, whereas in the case of the lead from the exploded case, it was still going on after 48 hours. The extent of the chemical action can be best judged by noting the bulk of the gas given off from a square foot of each of the samples of lead as follows :—

Cubic inches of hydrogen evolved from a square foot of lead surface by immersion in pure sulphuric acid in 48 hours :—

	No. 3.	No. 5.	No 6.
Hydrogen in cubic inches	41	16	⅛

From all these results the following conclusions may fairly be drawn:—1. That the sulphuric acid was good concentrated vitriol of first-rate quality, and free from any objectionable or exceptional property. 2. That the bulging of the cases was due to the evolution of hydrogen gas caused by the action of the sulphuric acid on the lead of the cases which contained it. 3. That any concentrated acid would have produced the same result with the same lead. 4. That the chemical action within the cases was produced by the extreme purity of the lead. This is quite apparent, from the fact that the impure lead was practically unacted upon, and although one of the samples received from Jas. Napier and Co. is a lead of great purity, and has been in use for chemical purposes for six months, I am clearly of opinion that that fact does not affect the correctness of this conclusion, as sulphuric acid is very far from being without action upon it, and I do not consider it a good lead for chemical purposes. The proportion of hydrogen given off in the 48 hours is the best test for the suitability of the lead for chemical purposes. The fact that concentrated sulphuric acid of any kind could act upon very pure lead producing hydrogen in quantity, at ordinary temperatures, has hitherto been unknown to me, and, so far as I am aware, to manufacturers of sulphuric acid generally, most of whom would at present, I believe, be surprised to know that such was the case. In future there will be no difficulty in distinguishing lead that is suitable for chemical purposes from that which is not, even without the necessity of making chemical analyses; but hitherto this has not, so far as I am aware, been considered necessary. — (Signed) Robert R. Tatlock, F.R.S.E., F.I.C., F.C.S."

On immersing pieces of lead in cold concentrated acid, the writer observed that the small bubbles of gas made their appearance first in lines in the direction in which the sheet had been rolled. It occurred to him then to try if thin sheets which had been passed repeatedly through the rollers were more readily acted upon than thick ones. Mr. James Stoddart, of the Clyde Lead Works, kindly supplied samples of various thicknesses, rolled from the same block of lead. The results were very anomalous, but showed no marked difference between the thick and thin sheet. Very wide differences, however, did occur between pieces cut from different portions of the same sheet, as will be seen from the following results:—The method employed was, simply placing several square inches of the lead in a small bottle fitted with a rubber stopper and bent tube, filling the bottle up to the neck with concentrated acid, and collecting the gas generated. The sheets were made from an English pig lead desilverised by the Pattison process. It was not analysed, but was evidently a soft pure lead somewhat similar to No. 5 in Mr. Tatlock's report.

Sheet Rolled to about 3 lbs. to the Square Foot.

Conditions.	No. of Hours in Acid.	Cub. in. Gas per Sq. Foot.	Remarks.
Dull surface as received.. ..	10	8·09	In every case the gas was nearly all given off during the first hour or so.
Dull	20	8·47	
,, ...	12	9·52	
Scraped clear ..	40	6·66	
,, ,, ..	2	12·80	Had been acted on by acid and re-scraped.
Average		9·10	

Sheet Rolled to about 4 lbs. to the Square Foot.

Dull	20	16·19	Rapid and energetic action.
,, ...	2½	5·23	
,, ...	Very little action.		
,, ...	12	12·58	
,, ...	12	11·42	
,, ...	12	9·14	
Scraped	1½	4·75	
,, ...	3	4·75	
,, ...	45	4·28	
Average		8·54	

Sheet Rolled to about 5 lbs. per Square Foot.

Dull	3	9·71
,, ...	12	10·85
,, ...	6	10·28
Scraped	—	15·95
Average		11·49

Sheet Rolled to about 6½ lbs. per Square Foot.

Dull	18	13·71	Brisk action.
,, ...	18	3·41	Very little action.
,, ...	18	11·42	In all cases the action was practically over in an hour or so.
Scraped	18	10·85	
Average		9·84	

Sheet Rolled to about 8 lbs. per Square Foot.

Dull	24	11·42
Scraped	24	4·75
Average		8·08

We offer no explanation of the cause of this irregularity in the above results, but the facts agree with our experience of the behaviour of some of our lead concentrating pans. We have frequently observed that certain pans did not wear equally, but gave way suddenly in local patches or spots. After this Mr. Stoddart kindly consented to prepare for us samples of the same brand of lead with small quantities of antimony, copper, zinc, &c., added. These were experimented on in precisely the same way, with the following results :—

Sample No. 1 consisted of 99·25 of the above brand of lead and 0·75 of antimony.

Four pieces, each 5 inches square, were separately immersed in the strong acid, and at the end of 24 hours neither of them had given off as much gas as could be conveniently measured. A very slight action was observed

for a minute or two after immersion, but it soon ceased. The gas given off from all four was collected together and measured; it was equal to ¼ of a cubic inch per square foot.

Sample No. 2 consisted of 99·25 same lead and 0·75 antimony.

Four pieces, each 5 in. square, were treated separately same as last. A very slight action was perceived at the moment of immersion, but after 5 hours in the acid not a single bubble of gas had come over from any of them, and all action had ceased.

Sample No. 3 consisted of 98·88 same lead, 0·75 antimony, and 0·37 copper.

Four pieces treated as before gave a slight reaction at first, and about one small bubble of gas passed over from each, in all equal to about one-tenth of a cub. in. per foot. After some hours' submersion these four pieces were cleaned and a clear bright surface scraped upon them, and again immersed in fresh acid. As before, a slight action was observed, lasting only for about one minute, and about the same quantity of gas was given off as before.

Sample No. 4 consisted of 99·63 same lead and 0·37 copper.

Four pieces treated as before gave, in the case of two of them, a very considerable reaction, and very little with the other two; probably the alloy was not equal throughout. The total gas given off equalled 1·42 cub. in. per square foot. The action lasted only a short time.

Sample No. 5 consisted of 99·63 same lead and 0·37 zinc.

Four pieces as before all gave a pretty equal action which did not last long; the gas given off equalled fully 2 cub. ins. per square foot. One of these pieces was scraped and again immersed in strong acid; a much brisker action took place on the clean surface, and gas equal to 3·4 cub. ins. per square foot was given off. A sample of a hard Bedminster lead was treated in the usual way and gave equal to 1·42 cub. ins. per square foot. Samples composed of 97 of the soft lead and 3 of the hard Bedminster, and of 98½ of the soft and 1½ of the hard, gave from ½ to 1 cub. in. gas per square foot. A sample cut from a large sheet composed of 99½ of the soft lead and ½ of the hard, gave a rapid and continuous action with the acid, far exceeding that of the two former samples made on the small scale. We intended to carry these experiments much further, but have not had sufficient opportunity. So far as the above experiments go, though not altogether satisfactory, they distinctly show that a small admixture of antimony, from ½ per cent to ¾ per cent, makes the best lead for chemical purposes.

Mr. W. G. Chrystal (of Messrs. John and James White) exhibited specimens of various leads cut from pans used by the firm in vitriol manufacturing. He said:—The firm to which I belong being, like other makers of vitriol, frequently troubled by the unsatisfactory way the leaden pans used in the concentration of the vitriol, stand, I determined to examine how the different sheets and brands stood the action of pure, strong, concentrated acid in the cold. For this purpose I took 1000 grms. of each beat out into thin plates of uniform size and thickness, so as to present the same surface in each case. These were placed in bottles containing in each 1750 fluid grms. strong pure sulphuric acid for exactly one month:—

	Loss in weight. Per cent.
The first specimens exhibited were cut from a pan which gave way in a very short time, and which was full of holes. Sample from this showed	31·20
Sample taken from another sheet of the same maker as the foregoing, being Glasgow rolled lead, before being used showed	15·60
Sample from another sheet as the above two, by the same maker..	11·60
Sample from a sheet of English rolled lead, before being used	6·40
Sample from another sheet as above	6·40

Various Brands of Lead.

L.L. "Llanelly," Welsh lead	25·36
L.H. "Lead Hills," Scotch lead	12·94
G.S. "Greenside," Cumberland lead ..	6·14
L.C. "La Cruz," Spanish lead	23·19
B.M. "Bedminster," Bristol lead	8·22

Mr. Chrystal exhibited several other specimens, some from pans, with large holes and with a peculiar honeycomb appearance, others from chambers showing cracks caused by the expansion and contraction of hard lead.

Mr. C. Hope gave analyses of specimens of lead cut from a vitriol pan which had been in use for some time at the St. Rollox Works. One of the specimens had been attacked, the other was entirely uncorroded. Analyses showed little difference in the composition of the specimens:—

	Corroded.	Uncorroded.
Lead	99·53	99·60
Copper	0·22	0·21
Zinc	0·17	0·13
Tin	absent	absent
	99·92	99·94

Dr. Wallace suggested, with reference to these two specimens, that the lead from which they had been cut had originally contained a larger proportion of zinc, but that the zinc, having crystallised out, as it were, in the lead, had been first attacked, and the greater part dissolved.

Mr. Mactear concurred in this view, and referred to the difficulty of getting a lead of uniform composition.

Mr. Stoddart (Clyde Lead Works) said that he had made experiments in this subject, and had found that a mixture of lead with zinc of fairly uniform composition could be obtained. When the desilverisation by the zinc process was carried out properly, no zinc remained in the lead; the lead was, in fact, nearly chemically pure. He suggested that a little dross accidentally mixing with the metal would afford a weak point at which the action of the sulphuric acid would begin, the oxide of lead being more readily attacked than the metal.

Mr. Ferguson mentioned that he had been connected with the lead trade for 25 years, and that the difficulties lead manufacturers had to contend with seemed to have increased rather than to have diminished within that time. He attributed this in great part to desilverizing by the zinc process, but thought that when the corrosion resulted in the formation of large holes in the lead it was to be attributed to oxide having been rolled out with the metal, as suggested by Mr. Stoddart.

Mr. R. R. Tatlock said it would be interesting to know if the durability of lead depended in any way upon the temperature to which they were exposed. About five years ago he had received for analysis samples of lead which had been exposed to a high temperature, and which had given way in a most extraordinary manner. He found that the lead was exceptionally pure, and, as the fact that pure lead is acted upon by sulphuric acid more readily than lead containing certain impurities was not generally known at that time, the firm on whose behalf he analysed the specimens would hardly credit his statement.

Mr. Mactear concluded the discussion. He reminded the section of a paper read by him last session (printed in Chemical News) which contained the results of experiments made by himself in this subject, and which also

gave an account of what had been previously done in the matter. With regard to the difficulty of obtaining uniform alloys, Mr. Chandler Roberts had found that even gold and silver could not be uniformly alloyed. Again, brass had been found not to be a true alloy. He did not believe that zinc could be combined with lead, and if it separated out in the lead it would afford a weak point at which the action of the acid would begin. He said that a distinction must be drawn between lead for the chambers and lead for the pans. The pans were exposed to a varying temperature. With regard to the lead employed for the latter he held it had been proved :—1. That chemically pure lead was unsuitable. 2. That lead containing certain impurities, and especially lead containing zinc, was unsuitable. 3. That the presence of certain metals, especially antimony, seemed to render the lead more durable. 4. That the most suitable lead had yet to be be discovered, and that the subject required further investigation.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 21, November 22, 1880.

Researches on Nitrogen Sulphide.—E. Demarçay.—This substance acts upon the chlorides of titanium, tin, phosphorus, arsenic, &c., producing one or more derivatives. The author has obtained SNCl in splendid crystals by mixing nitrogen sulphide with two or three volumes of chloroform, and passing chlorine gas through the liquid.

Phytolaccic Acid.—A. Terreil.—This acid exists naturally as a potassium salt in the fruits of *Phytolacca kæmpferi* and *Ph. decandra*. The free acid is amorphous and may be evaporated to dryness without decomposition. It neither precipitates silver nitrate, nor barium chloride, nor the salts of lime.

Determination of the Fatal Dose of Carbon Oxide for Various Animals.—M. Gréhant.—Air containing 1-300th of its volume of carbon oxide proved fatal to a dog when inhaled for fifty minutes. With another dog of the same size the fatal dose was 1-250th. A rabbit resisted various proportions up to 1-60th. A sparrow perished with 1-500th.

Observations on the Production of Pellagra, attributed to the Dietetic Use of Maize.—M. Fua.—The author shows from comparative instances that sound maize does not produce pellagra.

Zeitschrift für Analytische Chemie. Part 3, 1880.

Determination of Free Oxygen Dissolved in Water.—J. König and C. Krauch.—Already inserted.

Contribution to the Characteristics of the Alkaline Earths and of Zinc Oxide.—Dr. G. Brügelmann.—The alkaline earths and zinc oxide if their hydrates, carbonates, and nitrates are heated to complete decomposition, are obtained in the following forms and of the following specific gravities. Lime is obtained amorphous from the hydrate and carbonate, but in regular cubic crystals from the nitrate ; in either case of the sp. gr. 3·25. Strontia is obtained from the hydrate and carbonate amorphous, and of sp. gr. 4·5, but from the nitrate in regular crystals and of sp. gr. 4·75. Baryta is obtained from the hydrate in optically one- or two-axial crystals, of sp. gr. 5·32 ; but from the nitrate in regularly cubic crystals of sp. gr. 5·72. Magnesia is always obtained in the amorphous state, and of sp. gr. 3·42. Zinc oxide is obtained amorphous from the hydrate and carbonate of sp. gr. 5·47, but from the nitrate in hexagonal pyramids of sp. gr. 5·78.

Contribution to a Knowledge of Saponification of Fats.—Dr. von der Becke.—The name fat is generally applied to a mixture of the tri-glycerides of palmitic, stearic, and oleic acids. As regards the animal fats this assumption has been in all cases verified, but the vegetable fats display certain not unimportant deviations. J. König, J. Kiesow, and B. Aronheim, in saponifying vegetable fats, obtained invariably less glycerine than is required for forming the glycerine-ethers of the fatty acids —a fact pointing to the conclusion that free fatty acids must be present, since the quantity of cholesterine occurring in the plants is too small to combine with the fatty acids. For saponification potassium and sodium hydrate were used along with the other basic oxides, the latter substances being considered equal in value to the former, the only difference being that the products in the one case are termed "soaps," and in the other "plasters." It was assumed hitherto that the tri-glycerides, like other ethers, were completely decomposed by the above-named ethers into salts of the fatty acids and glycerine, and that equal quantities of glycerine were obtained in all cases. For the saponification of fats and the separation of the products, J. König had proposed a process which consists essentially in treating the fat operated upon with an excess of lead oxide in presence of water at 90° to 100°. The author when attempting at his request to saponify cacao-butter in this manner—in order to discover a process detecting the sophistications of this product—found that it could not be saponified with lead oxide, at least not in this manner. It was found on further experimentation that the quantity of glycerine obtained on saponification with potassium hydrate was in all cases considerably the highest. In the easily saponifiable fats, butter, lard, and olive oil, the difference was found less manifest, but it was much more distinct in those which are hard to saponify. Cacao-butter and tallow, if saponified with lead oxide, yield scarcely traces of glycerine. A mixture of an easily saponifiable fat like butter with cacao-butter gave the same quantity of glycerine as if butter alone were employed. It is possible that the reaction when once set up may extend itself. Hence it appears that in the case of some fats the method of saponification with oxide is not trustworthy, and that when the accurate determination of the proportion of glycerine in a fat is required, the saponification must be effected with potassium hydrate.

The Determination of Glycerine in Commercial Samples.—Dr. W. Lenz.

Volumetric Determination of Lead.—W. Diehl.—Already inserted.

Further Communications on the Reversion of Ferriferous and Aluminiferous Superphosphates.—Dr. C. F. Meyer.—Already inserted.

Apparatus for Preventing Liquids from Evaporating too far, and Safety-Contrivance for Water-Baths and Drying Apparatus.—Max Süss.—This apparatus cannot be intelligibly described without the accompanying woodcut.

Determination of Sulphur in Iron Pyrites.—Bernhard Deutecom.—On oxidising pyrites with nitric acid and precipitating the sulphuric acid from the ferriferous solution, slightly acidified with hydrochloric acid, the author always obtained a barium sulphate contaminated with iron, and still the results were too low. He therefore adopted the following process :—1 grm. pyrites was mixed in a large covered crucible with 8 grms. of a mixture of equal parts potassium chlorate, sodium carbonate, and sodium chloride. The crucible is heated at first gently so as to dry the contents, which are afterwards melted at a high temperature. The mass when cold is treated with boiling water, and the solution together with the deposit is introduced into a measuring-flask of 200 c.c.

filled up, filtered, and the sulphuric acid is determined in aliquot parts, say 50 c.c. The insoluble residue does not retain any sulphuric acid. In this manner the use of nitric acid is evaded. The decomposition of the potassium chlorate is complete.

The Electrolytic Determination of Nickel and Cobalt.—H. Fresenius and F. Bergmann.—Already inserted.

Electrolytic Determination of Silver.—H. Fresenius and F. Bergmann.—Already inserted.

Photometric Apparatus.—M. Gouy.—This memoir cannot be reproduced without the accompanying woodcut. In using Bunsen's photometer A. Töpler employs the following arrangement in place of the "grease spot":—Between two pieces of parchment paper, as thin as possible and equally translucent, is laid a moderately thick piece of common paper with a circular hole in its middle, and the three papers are laid between two colourless plates of glass. The translucent spot allows of as exact adjustment as the grease spot; but the latter, if viewed under a certain angle and caused to disappear between two sources of light, becomes visible again if viewed under another angle, a defect from which Töpler's arrangement is said to be free. According to J. M. Eder the separation of mercurous chloride which takes place under the influence of light in mixed solutions of mercuric chloride and ammonium oxalate is chiefly due to the ultra-violet rays of light, and is so regular that the quantity of the mercurous chloride deposited may serve as a measure for the intensity of these rays.

Rapid Method of Filtration.—J. de Mollins.—This apparatus cannot be described without the accompanying illustration.

Use of Glass-Wool in Filtration.—F. Stolba and R. Böttger.—Both these authors point out that glass-wool is attacked by various liquids, including hot water.

Detection of Alcohol in Ethereal Oils.—A. Drechsler.—The author employs as reagent a solution of 1 part potassium bichromate in 10 parts nitric acid of sp. gr. 1·30. Alcohol, if present, is at once betrayed by the pungent odour of ethyl nitrite.

Zinc Chloride as a Reagent for Alkaloids, Glycosides, &c.—A. Jorissen.—The author finds that the following bodies produce characteristic reactions with pure zinc chloride:—Strychnine, bright rose; thebaine, yellow; narceine, olive-green, delphinine, brownish red, berberine, yellow; veratrine, red; quinine, pale green; digitaline, chestnut-brown, salicine, violet-red; santonine, violet-blue; cubebine, carmine red. In case of strychnine the reaction can be produced with 1 decimilligrm. of the hydrochlorate. Brucine and aconitine, if present, interfere. To obtain the blue colouration characteristic of santonine, the mixture during evaporation must be continually stirred with a glass rod drawn out to a point. Digitaline gives first a green solution, similar to that produced by heating with hydrochloric acid. After evaporation there remains upon the porcelain a chestnut-brown spot which quickly blackens. The salicine reaction can be used for detecting the fraudulent addition of this body to quinine sulphate. Albumenoid substances, if heated for a time with the zinc chloride solution, leave a violet stain upon the porcelain, which may be distinguished by its instability from the colourations mentioned above. As a rule it quickly blackens. The author's method of operating is as follows:—A solution of the alkaloid or its hydrochlorate is evaporated to dryness upon the water-bath, say in the inside of the lid of a porcelain crucible; two or three drops of the test-solution—1 grm. fused zinc chloride in 30 c.c. concentrated hydrochloric acid and 30 c.c. water—are placed upon the residue, and afresh dried up on the water-bath. The colouration begins at the outer edge and spreads inwards as the water is expelled.

Journal de Pharmacie et de Chimie.
July, 1880.

Curare from French Guaina.—G. Planchon.—A botanical paper.

Gases Retained by Occlusion in Aluminium and Magnesium.—M. Dumas.—The substance of this paper has been already noticed. The gas occluded by aluminium is pure hydrogen. In magnesium the hydrogen is accompanied by small proportions of carbonic oxide and carbonic acid.

On Saccharine.—Eug. Peligot.—Saccharine is dextrorotatory; its power is expressed by 93 °5′, that of ordinary sugar being 67°·18′. The rotatory power is the same whether the saccharine is derived from starch, sugar, or levulose.

The Spectroscope Applied to the Chemical and Pharmaceutical Sciences.—M. Coulier.—Continued from the May number.

Insalubrity of American Pork.—J. L. Soubeiran.—Among the parasites observed in American pork are *Tricocephalus dispar*, *Stephanurus dentatus*, *Echinorhynchus gigas*, *Cisticercus cellulosæ*, *Fasciola hepatica*, and *Distomum lanceolatum*. *Trichina spiralis* is not uncommon in American hams. The author then mentions a special contagious disease which in 1878 destroyed 260,000 swine in North Carolina alone. At Chicago, diseased animals are killed and prepared for exportation without scruple.

Detection and Determination of Heavy Mineral Oils, Resin Oils, Fatty Oils, and Resin in Commercial Oils.—A. Remont.—Already abstracted.

Wines Mixed with Grape Sugar.—A. Schmitz.—The non-fermentible part of the grape sugar which is introduced into wines, if administered to dogs by way of subcutaneous injection, produced vomiting and other morbid symptoms. The author thinks that these residues contain a poison similar to that present in potato-oil.

Volumetric Determination of Quinine Sulphate.—G. Kerner.—To obtain a saturated solution of quinine the substance is ground up at the temperature of the operation with a quantity of water insufficient to dissolve it, agitating the mixture frequently and letting it settle for twelve to eighteen hours. The pure solution of ammonia is used of the spec. grav. 0·92. The quinine sulphate under examination is dissolved as follows:—5 grms. are ground up in an agate or porcelain mortar with cold distilled water, so as to make a homogeneous mixture, and the whole is poured into a bottle, using altogether 50 c.c. of water, and is left to itself for twelve to eighteen hours without rise of temperature, but with frequent and brisk shaking. After this the bottle is set in cold water. No account need be taken of the external temperature if the two solutions (quinine and ammonia) are standardised at the same temperature. A tall burette graduated into twentieths of a c.c. renders it possible to recognise 1-100 c.c. The author measures with a pipette 10 c.c. of the saturated solution of quinine sulphate into a test-tube and titrates as follows:—5 c.c. of ammonia are run at once into the quinine, the tube is closed with the finger, and inverted two or three times without shaking. The greater part of the quinine is precipitated and re-dissolved, but the liquid remains turbid. The ammonia is then run in, drop by drop, three-tenths, two-tenths, one-tenth, of a c.c., until after two inversions the liquid remains clear. The end of the reaction is indicated by the perfect limpidity of the mixture. The simultaneous titration of the standard solution of quinine shows the exact value of the ammonia and the surplus of the same solution of ammonia necessary for the titration of the sample indicates the proportion of cinchonidine sulphate present; 0. 288 c.c. ammonia at 0·92 correspond to millgrm. crystalline cinchonidine sulphate.

COMPOSITION AND QUALITY OF THE METROPOLITAN WATERS.

NOVEMBER, 1880.

	Total Solid Matter.	Oxygen required by Organic Matter, &c.	Nitrogen as Nitrates, &c.	Ammonia.	Hardness. Clark's Scale. Before Boiling.	Hardness. Clark's Scale. After Boiling.
	Grs.	Grs.	Grs.	Grs	Degrees.	Degrees.
Thames Water Companies.						
Grand Junction	22·42	0·071	0·146	0·001	15·4	2·4
West Middlesex	21·83	0·128	0·146	0·001	15·4	2·4
Southwark and Vauxhall	21·97	0·088	0·167	0·000	15·4	2·0
Chelsea	21·75	0·044	0·156	0·000	15·4	2·4
Lambeth	23·03	0·031	0·167	0·000	15·4	2·4
Other Companies.						
Kent	32·02	0·000	0·413	0·000	22·4	5·6
New River	22·91	0·004	0·198	0·000	15·4	2·4
East London	22·53	0·077	0·177	0·000	15·4	2·4

(The results are stated in grains per imperial gallon of 70,000 grains.)

NOTE.—The amount of oxygen required to oxidise the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours.

The water was found to be clear and nearly colourless in all cases but the following, when it was slightly turbid, namely:—The Grand Junction Water.

C. MEYMOTT TIDY, M.B.

MISCELLANEOUS.

Royal Institution.—Prof. Dewar will give the first of his Christmas lectures (adapted to a juvenile audience) "On Atoms," at the Royal Institution, on Tuesday next, December 28, at three o'clock.

Safety for Cheques: a New Invention.—Every person who has to pay away a cheque is naturally anxious that it should not be tampered with before being presented at his bankers. For this purpose not a few ingenious and complicated processes have been devised, all of which fail to baffle the patient subtlety of the modern forger. There are, *e.g.*, cheques where the part to be written on is tinted with aniline violet, whilst the back bears a design in ultramarine, and the paper itself is impregnated with Prussian blue. It might be thought the application of an acid to such a cheque for the purpose of removing the writing could not fail to decompose the ultramarine, whilst on the other hand, treatment with an alkali must destroy the Prussian blue and alter the tint of the ground. Yet we have seen the writing entirely removed from an experimental cheque drawn upon such paper, whilst the respective tones of the white, the blue, and the violet were pronounced by an experienced colourist to be entirely unchanged. Such being the case we think there is good scope for the simple and happy invention of Mr. A. A. Nesbit, F.C.S. He points out that in order to remove writing-ink solutions must be used which are either slightly acid or either alkaline. He proposes, therefore (Specif. No. 2184, A.D. 1880), to tint cheques with a dye which is affected by both acids and alkalies, but which takes one colour in acids and another in alkalies. He then prints upon the document partly in an acid and partly in an alkaline ink, so that the characters, designs, lines, &c., are apparent only in virtue of their respective alkalinity or acidity. If a forger moistens such a document with a dilute acid with a view to discharge any part of the writing, the colour takes the acid tint, and the words, lines, or other design disappear, and if it is placed in an alkaline solution the whole becomes alkaline, so that the words, &c., are not restored. If an alkaline solution were applied first the inscription would still disappear, and could not be revived by the subsequent application of an acid. Even if a perfectly neutral solvent were found capable of removing writing-ink it would still be impossible to alter such a cheque, as the acid portion of the lettering or design might be made a little stronger than the alkaline part, or *vice versa*, in which case the document, on an immersion in an alkaline solution, would be blurred. So far as we can perceive, this invention bids fair to put a stop to a most dangerous kind of fraud, and we have no doubt that it will be welcomed in financial circles.

MEETINGS FOR THE WEEK.

TUESDAY, 28th.—Royal Institution, 3 p.m. "Atoms," Prof. Dewar.
THURSDAY, 30th.—London Institution, 7.
—— Royal Institution, 3. "Atoms," Prof. Dewar.

TO CORRESPONDENTS.

Addresses Wanted.—A correspondent would like to have the addresses of a few firms who are refiners of cobalt and borax.

MR. J. S. MERRY,
ASSAYER AND ANALYTICAL CHEMIST,
SWANSEA.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V. GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

SOUTH LONDON CENTRAL PUBLIC LABORATORY.

A Department has been opened for the Private Instruction of Gentlemen in Practical Chemistry as applied to any Special Industries or Commercial Products they may wish to study. For Fees, &c., apply to W. BAXTER, Secretary, Central Public Laboratory, Kennington Cross, S.E.

BISULPHIDE OF CARBON

PROTOSULPHATE

RED OXIDE

OXYCHLORIDE

Sulphocyanide,

And every other Mercurial Preparation.

BISULPHITE OF LIME, TETRACHLORIDE OF CARBON.

Oxysulphuret of Antimony, Glacial Acetic Acid,

LIQUOR AMMONIÆ,
SULPHIDE OF IRON,
PURE ACIDS,
CHLORIDE OF SULPHUR,
ACETONE,
CHLOROFORM,
ALDEHYDE,
CHLORATE BARYTA,
ARSENIC ACIDS,
FRUIT ESSENCES FOR CONFECTIONERY & LIQUEURS,
PERCHLORIDE OF IRON,
SULPHITE AND HYPOSULPHITE OF SODA,
PHOSPHATES OF SODA AND AMMONIA,
ETHERS,
BROMIDES,
IODIDES,
SCALE AND GRANULAR PREPARATIONS,
SULPHIDE OF SODIUM.

ALSO,

Pure Photographic Chemicals of every kind.

MANUFACTURED BY

WILLIAM BAILEY & SON,

HORSELEY FIELDS CHEMICAL WORKS, WOLVERHAMPTON.

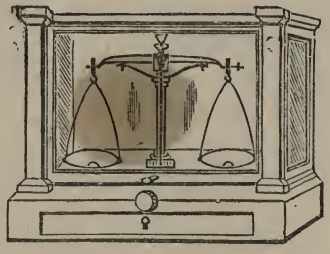
BECKER & SONS,

MANUFACTURERS OF

CHEMICAL AND GOLD ASSAY BALANCES AND OTHER

SCALES AND WEIGHTS.

ROTTERDAM.



NEW YORK.

BECKER'S STUDENT'S BALANCE, in polished mahogany glass case, sliding front, counterpoised, to carry 30 grammes in each pan and turn to ½ milligramme, nickel plated pans £2 10
Ditto, ditto, in mahogany glass case, polished black.. .. .. £2 13

Sole Agents for England, Ireland, and Wales:—

TOWNSON & MERCER.

Becker's Complete Lists forwarded by post on receipt of 1*d.* stamp or free on application.

BISULPHITE OF LIME.
BISULPHITE OF SODA.
ULPHITE OF SODA. TANNATE OF SODA.

WILLIAM MARRIOTT
CHEMICAL WORKS, HUDDERSFIELD

SILICATE OF SODA, Solid and in Solutions of Various Degrees of Concentration: the finest quality obtainable, and especially adapted for the use of Soap Makers and her Consumers.—JOSEPH CROSFIELD and SONS, Soap Makers, &c., Warrington.
London Agent—H. B. CLARKE, Great Tower Street, E.C.

GREENBANK ALKALI WORKS COMPANY (LIMITED),

ST. HELENS LANCASHIRE.

CELEBRATED RED HEART BRAND.

DOUBLE REFINED CAUSTIC SODA—Solid in Drums. or in a fine white powder in Barrels or Kegs, Total Impurity under $\frac{3}{100}$. For Fine Soap Makers, Oil Refiners, Dyers, Bleachers, &c. We specially recommend the *powdered* article for small consumers. Keeps perfectly without deliquescing. No trouble in breaking up, handling, or weighing exactly.

PURE CAUSTIC POTASH—In Iron Drums of any size. Total Impurity, including Soda, under $\frac{1}{100}$. A speciality for Soft Soap Makers, Oil and Lard Refiners.

REFINED PEARL ASHES OR PURE SALTS OF TARTAR *Total* Impurity, including Soda, $\frac{2}{100}$. With the exception of a trace of Soda this is almost an absolutely pure hydrated Carbonate of Potash: a Speciality for Fine Glass Making, Toilet Soap, and Fine Chemical Purposes. It is impossible to obtain elsewhere any other Salts of Tartar approaching this Refined Carbonate Potash in purity.

BICARBONATE OF POTASH—Perfectly pure white; finely powdered.

CHLORATE POTASH—Large Crystals or Very Finely Powdered. Impurity under $\frac{1}{1000}$.

PURE SULPHATE POTASH—Containing no Iron, Chloride, or Free Acid, only a trace of Soda.

Samples and Prices forwarded on application.
Orders for small quantities executed for Cash against Invoice.

BAILEY'S PATENT HOT-AIR ENGINE.

Made from ¼ to 5 horse-power. 56lbs. of coke will keep a 1-horse going 12 hours. 1000 galls. of water lifted 50 feet high for a penny.

NO BOILER. NO DANGER.

Awarded Prize Medal by the chief Societies.

SOLE MAKERS—

W. H. BAILEY & Co., Albion Works, Salford, Manchester

BETHESDA MINERAL SPRING,

WAUKESHA, WISCONSIN, U.S.A.

Invaluable in Diabetes, Bright's Disease, Urinary Diseases Dyspepsia. A Mild Aperient. Sold by all Chemists and Minera Water Agents. Agents wanted.

For special terms and further information apply to CEARNS and BROWN, 32, Chapel Street, Liverpool.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works Manchester.

THE CHEMICAL NEWS.

Vol. XLII. No. 1101.

ON CHICKEN CHOLERA: STUDY OF THE CONDITIONS OF NON-RECIDIVATION AND OF SOME OTHER CHARACTERISTICS OF THIS DISEASE.*

By M. L. PASTEUR.

In the communication which I had the honour of presenting to the Academy in the month of February last, I announced, among other results, that chicken cholera originates in a microscopical parasite; that there is an attenuated virus of this disease, and that one or more inoculations of this attenuated virus may preserve chickens from death when inoculated with the virus of maximum virulence. On account of the striking similarity that these two forms of virus present with the effects of variola and vaccine in man, it becomes interesting to ascertain not only if the immunity from the more aggravated form of virus is absolute, for the regions of the body which have undergone the preventative inoculation, but also if this immunity exists in the system, no matter what portion of the animal may have been inoculated, and what may have been the manner of introducing the virus.†

To explain with brevity the results which I have to communicate, I may be allowed to use the word *vaccinate*, to express the act of inoculating a chicken with the attenuated virus. This being admitted, I may state, as the result of many experiments, that the effects of vaccination are very variable. Some chickens are little affected by the most virulent virus after one inoculation of the attenuated virus; others require two such inoculations, and even three. In every case, the preventive inoculation does some good, because it acts in a certain measure. Vaccination, then, may be of several degrees; but we may always succeed in completely vaccinating a chicken, which means that we can bring it to such a condition that it becomes incapable of being affected by the most virulent virus.

To make this matter clear, I will now give the results of experiments:—I take eighty new chickens (I call *new* those which never suffered before with chicken cholera). On twenty of these, I inoculate the most virulent virus—and they all die. Of the sixty that remain, I take another lot of twenty, and I inoculate them with that quantity of the most attenuated virus which the point of the needle will take up ‡—and not one dies. Are they then vaccinated for the aggravated form of virus? Some are and some are not, for if I afterwards inoculate these twenty chickens with the most virulent virus, six or eight of them will not die, although they may be ill, while in the first case every inoculated chicken died. I take again from the remaining chickens another lot of twenty, and these are vaccinated with the attenuated virus exactly as the preceding lot, and, a week afterwards, they are again vaccinated in the same manner. Are they now safe from the virulent virus? We now inoculate these twenty chickens with this virulent virus, and, instead of there being six or eight which do not die, there are twelve or fifteen. Finally, I take the twenty remaining chickens, and vaccinate them successively three or four times. If now I come to inoculate them with the most virulent virus, not one will die. In this case, chickens are brought to the condition of animals who are incapable of suffering from chicken cholera.

As to the cause of non-recidivation, I find it impossible to resist the idea that the microscopic germ, which causes the disease, finds in the body of the animal conditions suitable to its development, and that to satisfy the necessities of its life, the germ alters certain substances, or destroys them, which comes to the same thing, whether it assimilates them, or whether it consumes them with oxygen borrowed from the blood.

When complete immunity has been reached, the most virulent germ may be inoculated into any of the muscles without producing any effect. This means that the cultivation of the germ has become impossible in these muscles. They no longer contain food for the germ.

It is impossible to convey the impression that one receives from observing such phenomena. Here are twenty chickens which never had this disease. I inoculate them in their pectoral muscles or, still better, in the muscle of the thigh, so as to observe with greater ease the effect of the inoculation. The next day all the chickens are lying down; they are very lame and seem overcome by sleep. The inoculated muscle becomes of enormous size, and is profusely filled with the parasites. From time to time, a chicken dies, and, at the end of forty-eight hours, they are all dead. We may take also twenty chickens, previously vaccinated several times, and inoculate them at the same time as the others, with the same virus, in equal quantities. The next day and the next, they are all alive and in good health; they eat and cackle as usual; the cocks crow; the inoculated muscles present nothing abnormal. There is not even a sign to show where the skin was punctured. This healthy condition remains permanent.

We may now inquire whether the impossibility of cultivating the parasite is not limited to the muscles which have been inoculated. This may be answered by introducing the deadly virus in the blood vessels and in the digestive organs. I have taken ten chickens, never before inoculated, and ten others inoculated several times with the mild virus. I have then injected the worst form of virus in the jugular vein of all these chickens. The first ten have died rapidly; many of them within twenty-four hours. The ten vaccinated chickens, on the contrary, have only been slightly ill from the incision of the skin and of the jugular vein, and were soon in good health. This shows that the blood of these ten chickens was itself *vaccinated*, which means that previous cultivation had deprived it of the materials fit for further developments of the germ.

As to the introduction of the parasite in the digestive organs, I have imitated the epidemics which depopulate poultry yards, by introducing the parasite in the food of the chickens. On the 11th of March I brought together twelve chickens, bought at the market that very morning, and twelve others, previously vaccinated several times. Every day I gave to these twenty-four chickens a meal of the diseased muscles of chickens, who had died from chicken cholera. Through the combs of the twelve chickens which had not been vaccinated I passed a platinum wire, so as to distinguish them from the other twelve. On the next day, the unvaccinated chickens began to sicken and die. On the 26th of March, the experiment terminated. Seven of the chickens that had not been vaccinated have died, and a *post mortem* examination reveals the fact that the disease was introduced in the system, either through the first portion of the alimentary canal, or more frequently, through the bowels, which were highly inflamed, and sometimes ulcerated, in a manner which recalls the lessons of typhoid fever.* The five other un-

* Translated from the *Comptes Rendus de l'Academie de Sciences*, of April 26th, 1880, page 952, by P. Casamajor. The translation of the first paper of this series appeared in the Chemical News, vol. xli., page 4 (July 2nd, 1880).

† From all I have seen and read of vaccine in man, and from my experiments on chicken cholera, I infer that *vaccine* rarely acts as a complete preventative. There are cases cited of vaccinated persons who have had the variola, and there are even cases of persons who have had it, afterwards, as much as three times.

‡ There are degees of attenuation as well as of virulence. I will give explanations in a future communication.

* The blood is full of parasites, and the interior organs are frequently covered with pus and false membranes, particularly next to the intestinal pockets, through which the germ seems to have penetrated.

vaccinated chickens are more or less ill, one seriously so. As to the twelve vaccinated chickens, not one has died, and to-day * they are all alive, and in good health. We may now sum up the results as follows :—

It is the life of a parasite, in the interior of the body, which causes the disease known as chicken cholera and which causes death by this disease. When the cultivation of this parasite cannot take place in the body of a chicken, the disease does not show itself. The chicken is then in the constitutional condition of animals which chicken cholera cannot attack. Animals, in this condition, may be said to be born vaccinated for this disease, because the fœtal evolution has not placed in their bodies the proper food of the parasite, or because substances, which could serve as such food, have disappeared while they were yet young. We must not wonder that there are constitutions more or less apt to receive inoculations of certain kinds of virus, for, as was announced in my first note, the broth of beer-yeast is entirely incapable of supporting the life of the parasite of chicken cholera, while it is well adapted to the cultivation of a multitude of microscopical germs, notably of the bacteridia of carbuncular disease.

The explanation to which we are led by the facts already mentioned, of the different degrees of constitutional resistance of some animals, as well as of the immunity which chickens acquire by preventive inoculations, must seem a natural one, if we take into consideration that every cultivation modifies the medium in which it takes place. In the case of ordinary plants, the soil is modified; in the case of parasites, the animals and plants on which they live are also modified. The same thing happens with the liquids in which they live, in the case of ferments and other microscopical germs. The modifications which take place have this character in common, that new cultivations of the same species in these media soon become difficult or impossible. If chicken-broth is used for cultivating the germ of *chicken cholera*, and if, after three or four days, the liquid is filtered, to separate all the germs, and furthermore, if after this fresh quantities of the germs are placed in the filtered liquid, it will be found incapable of producing the feeblest development. Perfectly limpid at first, the liquid remains indefinitely limpid.

We are led to believe that the cultivation of the attenuated virus in a chicken places its body in the same state as that of the liquid which can no longer sustain the life of the germ of disease. We may extend the comparison still further, for, if we filter the broth on the second day of the cultivation, instead of on the fourth, the filtered liquid will still permit the cultivation of the germ, but less readily than at first. This may enable us to understand that the cultivation of the attenuated germ in the body of a chicken may not have removed all the food for the germ. The remainder may allow a fresh cultivation of a feebler kind. This is the same as a first *vaccination*. Subsequent inoculations will remove progressively all the materials for the cultivation of the parasite. Through the action of the circulation, a time will come when any new cultivation on the animal will remain unproductive. Then the disease cannot recidivate, and the subject becomes perfectly vaccinated.

It may seem astonishing that the first cultivation could have stopped before all the food of the germ has been destroyed; but we must not forget that the germ is aerobian,† and that, in the body of an animal, it does not find the same conditions as in an artificial medium of cultivation, in which there are no obstacles to its propagation. In the body, on the contrary, it finds opposition from the cells of the organs, which are also aerobian, and are continually absorbing oxygen.

We might also account for the fact of non-recidivation by admitting that the life of the germ, instead of destroying certain substances in the body of an animal, on the contrary, adds other substances which act as an obstacle to its further development. The history of the life of these inferior beings, of all beings in fact, authorises this supposition. The excretions due to vital functions often prevent vital functions of the same nature. In some fermentations, antiseptic products are formed while fermentation is going on, and even by the action of ferments, and these products put an end to further action, even if there are still substances left capable of undergoing fermentation. In the cultivation of our germ, there might, in the same way, be substances formed whose presence might explain non-recidivation and vaccination.

Our artificial cultivation of the parasite will enable us to examine this hypothesis. If we prepare an artificial cultivation of the germ of chicken cholera, we may evaporate the liquid *in vacuo* while cold, then bring it back to its original volume by the addition of chicken broth. If the extract contains a poison which destroys the germ, and if the presence of this poison is the cause of its non-development, the cultivation of the germ cannot take place in this liquid. On the contrary, the development does take place without difficulty. We cannot then believe that, during the life of the parasite, there are substances produced which prevent its further development. This is a corroboration of the opinion which we have expressed on the cause of non-recidivation in certain virulent diseases.

* April 26th.

† Pasteur divides germs and other microscopic organisms into *aerobians* (requiring air to live) and *anaerobiæ* (which do not require air). —*Translator.*

ON THE

MANUFACTURE OF SULPHATE OF SODA BY THE DIRECT PROCESS.*

By JOHN HARGREAVES.

In compliance with the invitation of our Secretary, I have the pleasure of placing before you the following paper on the Manufacture of Sulphate of Soda by the Hargreaves and Robinson direct process.

This process was first brought before the public about ten years ago, and since that time has slowly but surely made its way, its superiority over the old process being now clearly established in every point.

As the chemistry of the process is so well known, I will confine myself exclusively to its technicalities.

The first working apparatus erected consisted of four brick chambers of 6-ft. cube. With this arrangement difficulties arose in consequence of leakage of the gases from one chamber to another without passing through the columns of salt, from the chambers into the flues, and *vice versa*. These, together with the leakage of air, necessitated a very large consumption of fuel. To overcome these evils a second experimental apparatus—consisting of four cast-iron cylinders, each 10-ft. diameter by 10-ft. high—was erected in a double line. This practically got rid of the leakage. But the small amount of material and the shortness of the column, together with a relatively large amount of radiating surface, showed the advisability of increasing the size of the apparatus. With this object two other cylinders of the same dimensions were added to the series. This addition, although giving improved results, still fell short of the object in view, and the cylinders were afterwards pulled down.

The next apparatus consisted of eight cylinders of 12-ft. diameter, by 12-ft. high, which were erected in a single line: each cylinder having two fire-places and two discharging doors placed on opposite sides. The sulphurous acid pipe was placed on one side, and the circulating pipe connecting each of the end cylinders on the other side of the line of cylinders.

This arrangement gave a long column of salt, but exposed too much cooling surface, and consumed more

*A Paper read before the Members of the Faraday Club, in Liverpool, December 15th, 1880.

fuel than was desirable. But this was afterwards greatly reduced by erecting another line of eight cylinders so arranged as to form a double row with one fire-place and one discharging door to each cylinder. This reduced the fuel to about one-eighth of that previously required per ton of sulphate, for, while the production of the plant was doubled, the total fuel consumption was reduced to about one-fourth. This most remarkable result was another confirmation of the fact that, the larger the quantity of material operated upon, the smaller the proportion of fuel required.

Four sets of plant, having a total of thirty-eight cylinders of 15-ft. diameter by 12-ft. high, were next erected by several firms. Each set was arranged in two rows with an archway betwixt, having two fires and two drawing doors to each cylinder for the convenience of quick discharging and re-heating. Twenty cylinders of the same size, but arranged back to back, and with only one fire-place and drawing-place to each cylinder, were afterwards erected by the Atlas Chemical Company. The working of these cylinders proved that it was quite practicable to discharge the contents of each through one drawing-door. All the foregoing experience pointed in the direction of still further increasing the dimensions of the cylinders, and arranging the apparatus compactly, so as not to expose an excessive amount of radiating surface. Convinced of this fact, the same firm decided to erect another set of cylinders of larger dimensions than any yet attempted—viz., twelve cylinders of 18-ft. diameter by 12-ft. high, each containing 55 to 60 tons of sulphate. Several important improvements were introduced into this apparatus. In the previously erected plants the gas, after descending through the mass of partly-converted sulphate, was conducted from the bottom of each cylinder to the top of the next by means of an external pipe connected to the lower part of the cylinder. In this apparatus these external pipes are replaced by D-shaped pipes arranged in the interior of the cylinders, by which leakage of air into the upcast pipe is entirely prevented, and, besides, has the advantage of placing all the connecting joints at the top of the cylinders where they can be got at. The brickwork is also simplified, and now consists of a 9-in. ring round each cylinder, with an outer wall enclosing the whole series, the remaining spaces other than the fire-places and flues being filled up with concrete to prevent loss of heat. The hydrochloric acid is taken from the top of the circulating pipe through a movable wrought-iron syphon to a pipe fixed above the two lines of cylinders. This has considerable advantages over the earlier system of taking the exit gases through the drawing-doors, and thence by an underground flue to the exhausters, as it effects considerable economy in the amount of iron used in construction, and decreases the number of joints.

This plant also contains the recently-improved firing arrangements, by which the heat from the fire-places is more evenly distributed, and local heating of the cylinders rendered almost impossible, no matter how carelessly the workman may fire.

Respecting the question of fuel required to maintain the temperature of the cylinders, I may here note that one of the best conducted plants is now fired almost exclusively, not with coal, but *cinders obtained by riddling the ashes from other furnaces in the works*, and of this inferior fuel less than 2½ cwts. is required per ton of sulphate made, and consequently the cost of repairs to fire-places is almost *nil*.

The salt was originally prepared by moistening with water, and forming into lumps by drying on floors heated from beneath, and afterwards broken into small pieces by a mill. This preparation is now performed entirely by machinery. The moistening is effected by the waste steam from the engine supplying the motive power. This steam passes into a box in which the salt is agitated by revolving arms. It then passes on to an endless band formed of a series of iron plates, where it is stamped and cut into suitable pieces. It then enters the drying oven, where, after being brought into direct contact with the products of combustion, it arrives at the other end in a suitable condition for putting into the cylinders. It is important that the prepared salt be sufficiently porous to allow the diffusion of the gaseous reagents, and also free from dust, so as not to close the passages through which the gases circulate in traversing the cylinders.

The kind of salt varies with the purpose for which the sulphate is required. Ground rock, surface evaporated salt, sweepings from salt works, and other cheap sources of salt are largely used for the process where sulphate is made for alkali manufacture.

When it is required to use the sulphate without refining for the manufacture of plate glass, it is necessary to use salt containing only traces of iron.

The salt prepared by Mr. Otto Pohl's method works exceedingly well in the direct process. His system consists in evaporating the brine by bringing the products of combustion into direct contact with it in one vessel, while above there is a pan in which another quantity of brine is heated from below. It is found much more economical than the ordinary system of salt manufacture both as to fuel, labour, and working space, and, hence, affords a supply of salt at a much lower cost. I have here samples of this salt kindly furnished by Mr. Pohl.

Any carbonaceous matter contained in salt used for the direct process is quickly burnt out in the cylinders, leaving a perfectly white sulphate.

When a cylinder is filled with salt it is made the exit of the series, and quickly becomes elevated to a working temperature (which may be estimated at 400° C.) by the hot gas coming from the previous cylinders, and also by the action of the small fire attached. As soon as the formation of the sulphate commences, the temperature rises rapidly, rendering the further application of external heat unnecessary until—in consequence of the small amount of chloride remaining—the heat, generated by chemical action, diminishes.

As the salt becomes converted into sulphate it is brought nearer and nearer to the source of sulphurous acid, the proportion of which, passing the cylinder, increases daily until it becomes the first cylinder in the series, when it receives the red-hot gas coming direct from the burners, which quickly decomposes the remaining chloride.

The time occupied in decomposing the contents of a cylinder varies with the kind of salt and the size of the pieces employed, but under ordinary circumstances should not exceed twenty-one days, and has often been done in less than fourteen days.

When the charge is decomposed the cylinder is isolated by closing the dampers connecting it with the sulphurous pipe and the succeeding cylinder, which latter in its turn is made the first in the series. The drawing-door is now opened, and the sulphate discharged; after which the cylinder is re-filled, and again made the last in the series.

The amount of cubic capacity required in the cylinder per ton of sulphate per week is about 170 to 180 cubic feet.

The pyrites burners, with the exception of being better protected against heat losses, are the same as used in the old process.

The draught from the burners is obtained by means of exhausters placed on the passage from the cylinders to the condensers. The waste steam from the engine driving these, after passing through a superheating coil, heated by the waste products of combustion coming from the cylinder fires, is mixed with the sulphurous acid in the burners to supply the necessary water vapour for the decomposition of the chlorides. Besides being an economical source, this has the advantage of automatically regulating the supply of steam to the sulphurous acid, which must vary with the speed of the engine driving the exhausters.

Neither the hydrochloric nor sulphur acids have any

appreciable effect upon the iron-work of the apparatus, as the temperature is always in excess of that required to keep then in the gaseous condition.

The condensers used are same as in the the old process, but, the gas comes in a continuous stream, there is no necessity for the frequent variation of the supply of water to the condensers which is required to condense the acid from pots.

The advantages claimed are briefly as follows :—

1st.—Although the cost of apparatus is about the same as that required for the old process, there is this difference: That whereas the life of a vitriol chamber may be estimated at—say ten years, the cylinders used with ordinary care in the direct system show every sign of lasting three times that period without renewal.

2nd.—Less fuel, being about one-half that required by the old process.

3rd.—Less labour, and, with the exception of the burner men, and one intelligent person to look after the plant, no skilled labour is required. Hence, less difficulty in dealing with the workmen.

4th.—Less repairs. In the instance of one apparatus which has been working several years, I am informed that this item is less than 6d. per ton of sulphate made.

5th.—No nitrate of soda necessary.

6th.—Cheaper qualities of salt—not available for the old process—are used.

7th.—Less sulphuric amongst the hydrochloric acid. Consequently less annoyance from sulphate of lime in the Weldon process.

8th.—No leakage of hydrochloric acid into the fire flues, the whole of it passing through the exhausters.

9th.—The sulphate when drawn emits no hydrochloric or sulphuric acid to annoy the workmen.

10th.—Sulphate is made containing only very small quantities of chloride and free acid, and, therefore, especially adapted for the manufacture of 76 per cent or other high strength caustic, for which it it is largely used. The manufacturers, whilst guaranteeing this quality to contain less than 0·5 per cent chloride of sodium, often supply it with less than 0·2, and even as low as 0·5 per cent chloride. I need hardly say that sulphate of such a quality commands a decided preference over that made by the old process, and in practice sells for about 2s. 6d. per ton over the ordinary market rate.

Sulphate made by this process is also used without refining for the manufacture of plate glass, and is superseding that of the old process which has to be refined at an additional cost of 25s. and upwards per ton before it is fit for this purpose.

Lastly, a reduced cost of production, which may be fairly estimated at 15 to 20 per cent.

In conclusion, the process is now rapidly extending. Eight sets of apparatus are now at work, three others are in course of construction, giving an aggregate capacity of production of about sixty-seven thousand tons per annum. Arrangements are also being made for the immediate erection of additional apparatus.

WATER FROM A HOT SPRING, NEW BRITAIN.*

By A. LIVERSIDGE,
Professor of Geology and Mineralogy in the University of Sydney.

The sample of water forming the subject of this note was collected from a hot spring in one of the islands of the New Britain group by the Rev. George Brown, Wesleyan missionary, to whom my thanks are due for the trouble taken in safely bringing it to Sydney.

The water was of a yellow tinge, and smelt of sulphuretted hydrogen: at first it was neutral to test-papers, but afterwards became very faintly acid, probably from the oxidation in part of the sulphuretted hydrogen.

No attempt was made to determine the amount of sulphuretted hydrogen and other gases, inasmuch as the quantity of water was but small, and moreover on account of the time which had elapsed since its collection (some few months), it was thought that the amounts of gases present at the time of examination would afford but little information as to the actual quantities contained by the water when freshly collected.

The residue left on evaporation to dryness at 100° C. amounted to 36,312 parts per 1,000,000, or 2541·84 grains per gallon, which is about the same as average sea-water.

Composition of the Residue, dried at 100° C.

	Per cent in residue.	Parts per million of water	or Grains per gallon.
Silica	0·200	72·6	5·08
Alumina and iron sesquioxide ..	0·440	159·7	11·18
Calcium sulphate..	1·394	506·2	35·43
Calcium chloride ..	2·240	813·4	56·93
Magnesium chloride	4·710	1710·3	119·72
Sodium chloride ..	87·320	31707·6	2219·53
Potassium	traces	—	—
Combined water ..	3·696	1342·2	93·97
	100·000	36312·0	2541 84

WATER FROM A HOT SPRING, FIJI ISLANDS.*

By A. LIVERSIDGE,
Professor of Geology and Mineralogy in the University of Sydney.

When at Kandavu, Fiji Islands, in 1876, I heard of the boiling springs at Savu Savu, but to my great regret my stay of three or four days only at Kandavu was too short to allow me to visit them, and I am indebted to the kindness of Dr. T. D. Bromlow, R.N., for the sample of water forming the subject of this note.

The water was contained in clear glass bottles, well corked and sealed. I mention this because the sample had evidently been collected with great care. On more than one occasion I have received samples of mineral waters which proved to be worthless for chemical investigation simply because insufficient care had been exercised in the collection and bottling. This was often a source of regret to me, since much trouble must have been taken to procure the samples, and still more to get them safely to Sydney. When distant from towns it is, of course, not always possible to obtain glass-stoppered bottles, but when procurable there is nothing so convenient and suitable as the large half-gallon bottles known as Winchester quarts.

The water was clear and colourless, after the deposition of the small amount of matter which it had in suspension, free from smell, but with a strongly marked saline taste; to test-papers it was neutral, or but very faintly alkaline. On evaporation to dryness the filtered water left a very white, extremely deliquescent, residue, which on ignition fused but did not blacken, thus showing the absence of any appreciable amount of organic matter.

The specific gravity of the water was found to be 1·0064 at 60° F.

The total quantity of solid matter in solution, weighed after drying the residue at 110° C., was found to be 8·320 parts per million, or 582·40 grains per gallon; but after driving off the combined water at a dull red heat, the residue was reduced to 7813 parts per million, or 546·91 grains per gallon—*i.e.*, it lost 6·09 per cent.

The rarer elements were carefully sought for in this residue by means of the spectroscope, but none were found. The total quantity of water at my disposal was but small—some four pints: perhaps a larger quantity would have enabled one to detect their presence. Neither iodine nor bromine could be found, although carefully sought for.

* Read before the Royal Society of New South Wales, Sept. 1, 1880.

* Read before the Royal Society of New South Wales, Sept. 1, 1880.

Composition.

	Per cent in residue.	Parts per million or of water	Grains per gallon.
Silica, insoluble ..	1·681	133·3	9·20
Silica, soluble	0·074	5·8	0·40
Alumina and traces of iron sesquioxide ..	0·534	41·7	2·92
Aluminium chloride	1·646	128·6	9·00
Phosphrc. acid (P_2O_5)	traces	—	—
Calcium chloride ..	46·754	3652·9	255·70
Calcium sulphate ..	4·770	372·7	26·09
Magnesium chloride	0·154	12·0	0·84
Sodium chloride ..	42·171	3294·8	230·64
Potassium chloride..	1·756	137·2	9·60
Carbonic acid	traces	—	—
Loss	0·465	34·0	2·52
	100·000	7813·0	546·91

From the above it will be seen that the salts in solution consist of chlorides for the most part, and that the chlorides of calcium and sodium largely preponderate over the others: the amount of calcium chloride is unusually large.

No mention was made by Dr. Bromlow of the temperature of the water.

NOTE ON THE ANALYSIS OF SHODDY AND WOOL WASTE.

By JOHN HUGHES, F.C.S.

For some time past it has been the practice for manure manufacturers to purchase shoddy at so much for each unit of ammonia per cent per ton, the ammonia being calculated from the yield of nitrogen as determined by the usual combustion process with soda-lime.

If the samples are fairly drawn, carefully prepared for analysis, and the analytical operations be skilfully performed, the results obtained should be so satisfactory that there should not be a greater difference than one-tenth to two-tenths per cent in the ammonia determinations of duplicate samples. Unfortunately, however, the difference between the percentage of ammonia found by the seller's chemist and that found by the buyer's chemist frequently amounts to as much as one, or even two, per cent; and, as each unit of ammonia is valued at from 6s. to 7s., a very serious loss is incurred by one of the two parties to the contract.

During the past eight years a great number of samples of shoddy have been submitted to me for analysis, and I am fully convinced that manufacturers have frequently been called upon to pay for what they have never received.

In this note, therefore, I wish to call particular attention to one source of error introduced in the preparation of the sample for analysis, namely, that some chemists do not take the trouble to determine the proportions of water and dry matters (containing the nitrogen) present in the shoddy as received by the analyst. The practice too frequently adopted is to turn out the sample and proceed to cut it up into a fine condition, without any regard to the loss of moisture which goes on during this process to a greater or less extent, according to the temperature of the laboratory.

When the shoddy is dry and contains not more than 16 per cent of water, this loss is inconsiderable and need not be noticed, but in the damp samples with 26 to 30 per cent of water, the loss of moisture during the making of the sample frequently amounts to 10 per cent or *more*, if the temperatute of the room is at all high and the shoddy be much handled during cutting-up.

The consequence is that the percentage of ammonia is given for the partially dried sample rather than for the shoddy as received.

From this cause alone the ammonia is stated 1 per cent too high in many cases.

It is the duty of the analyst to report the analytical results for the sample *as received*, and he should take all necessary precautions to correct any possible sources of error, either in the preparation of the sample or in the analysis itself. He must be aware of the great pecuniary importance attached to the analysis of all samples officially sealed in duplicate.

The following is the plan adopted by myself in the preparation of samples for analysis:—

The shoddy is turned out of the bottle and any large lumps pulled to pieces, after which about 40 grms. are weighed out and water determined by drying in a water-bath; a portion of the sample is returned to the bottle in case of reference, while the remainder is cut up very fine for analysis.

The nitrogen determination is made in duplicate, also a water determination that we may ascertain how much moisture has been lost in the preparation of the sample and make the necessary correction in the ammonia results.

Thus, suppose that the original damp shoddy as received contained 26 per cent of water and 74 per cent dry matter, and the prepared sample, as analysed, 16 per cent of water, 84 per cent of dry matter, yielding 9·50 of ammonia; we have only, therefore, to calculate how much ammonia would be yielded by the 74 parts of dry matter present in the original sample, as received, thus:—

Shoddy as Analysed.			Shoddy as Received.		
Dry Matter.		Ammonia.	Dry Matter.		Ammonia.
84	=	9·50	74	=	8·37

It will be seen that there is 1·13 per cent more of ammonia found in the prepared sample analysed than in the original sample as received. Now, at 7s. per unit of ammonia on a delivery of 50 tons, this would amount to £19 15s. 6d., which sum, the purchaser is asked to pay on behalf of ammonia which he has not received, and which consequently will not appear in the manufactured manure.

In the following table the respective analytical statements of two chemists are recorded, in reference to duplicate sealed samples of shoddy:—

	Buyer's Chemist.				Seller's Chemist. Results given on Certificate.	
	Shoddy as Analysed.		Shoddy as Received.			
No.	Water.	Ammonia.	Water.	Ammonia.	Ammonia.	Water.
1.	29·67	7·13	38·58	6·23	8·00	Not stated
2.	15·64	9·13	20·72	8·57	9·69	—
3.	18·30	9·16	24·01	8·53	9·14	—
4.	22·48	8·36	27·52	7·83	9·00	—
5.	15·30	10·00	25·57	8·81	8·59	—
6.	15·02	8·89	22·46	8·12	9·38	—
7.	13·76	9·22	21·14	8·43	9·54	—
8.	18·08	8·59	26·40	7·72	8·65	—
9.	24·08	7·66	30·46	7·02	8·51	—
10.	Very dry	9·75	Very dry	9·75	9·63	—
11.	15·30	8·79	17·76	8·54	10·08	—
12.	Very dry	9·55	Very dry	9·55	9 95	—

It will be understood that the results stated on the certificate of the Buyer's Chemist are those included in the column headed, "Shoddy as received." The percentage of water has been estimated by direct determination, and the proportion of ammonia present in the sample received has been carefully calculated from the nitrogen found in the partially dried "Shoddy as analysed."

The Buyer's Chemist, however, gives no details as to the percentage of water present in the sample; and from the high ammonia results it would appear that the shoddy must have dried considerably during the cutting-up process.

It will be noticed that only in two cases (Nos. 5 and 10) does the Seller's Chemist give a lower percentage of ammonia, and that in all the other ten instances his results are higher, in many of them there being an excess of at least 1 per cent more ammonia.

Not a little singular is it to observe that in Nos. 3, 7, and 8 the results for the sample, *as analysed* by the Buyer's Chemist *do agree* remarkably with the figures given by the Chemist of the Seller. Also, let it be noted how closely the results of both chemists agree in the two samples, Nos. 10 and 12, which are described as being very dry.

Finally, we must observe that with 38·58 per cent of water, No. 1 is represented by one chemist as containing 8·00 of ammonia, and by the other only 6·23 per cent. Now, as the average quality of good shoddy only shows about 9 per cent of ammonia associated with 15 per cent of water, and 85 per cent of dry matter, it is impossible that 8 per cent could be found in shoddy containing 38·58 per cent of water, while, on the other hand, if it did contain 8 per cent ammonia, it follows that there could not have been 38·58 of water in the sample analysed by the Seller's Chemist.

With a view of removing such discrepancies, I beg to make the following suggestions:—

1. That samples of shoddy should be drawn as fairly and impartially as possible; that the buyer and seller's representative should not be allowed respectively, to select samples, but that official samples should be taken by a lad (blindfolded, for a wool dealer could easily select a superior quality for his sample.
2. That each sample should consist of at least 1 lb., that four of such 1 lb. samples should be drawn, placed in wide-mouthed jars or bottles, and officially sealed; two samples being given to the buyer and two to the seller.
3. That the chemist be requested to state on the analysis certificate the proportions of *water* and (nitrogen equal to) *ammonia* found in the sealed sample as received.

If these suggestions be followed, I venture to hope that the analytical results will show a much greater uniformity and tend to reflect more credit on the profession of analytical chemist, while the practical results will be still more satisfactory to the manufacturer, who will only pay for the ammonia actually received; he will also be better able to control the percentage of ammonia in the manufactured manure. At the same time the regular determination of the percentage of moisture will tend to discourage the too common practice of adding water to increase the weight, while hoping, through the negligence of the chemist, to escape detection.

If necessary let the price per unit of ammonia be raised, but by all means let us endeavour to obtain correct analyses.

Analytical Laboratory, 79, Mark Lane, London, E.C.,
November 29, 1880.

DETECTION OF STARCH-SUGAR MECHANICALLY MIXED WITH COMMERCIAL CANE-SUGAR.*

By P. CASAMAJOR.

(Second Paper.)

In a previous communication on the same subject,† read before the American Chemical Society at the meeting of March, 1880, I gave several processes for the detection of starch-sugar in commercial sugars. One of these consisted in adding to the suspected sugar a quantity of cold water, somewhat less than its own weight, and stirring the mixture for a few seconds. If starch-sugar is present, it will be seen in the shape of white chalky specks.

Quite lately a sample of yellow refined sugar was given to me which was supposed to be adulterated by being mixed with starch glucose. By applying the test just mentioned, there seemed to be left a few small chalky specks, which dissolved after standing a minute or two, making it very uncertain whether any starch glucose was present. Upon repeatedly trying the same test the result was always doubtful.

I was then led to treat the suspected sugar by a liquid capable of dissolving sugar, but without any solvent action on starch-glucose. After many trials, I found that methylic alcohol of such density as to mark 50° by Gay-Lussac's alcohometer answered the purpose very well, if previously saturated with starch-sugar, as this solution dissolves cane-sugar, either white or yellow, very readily, but does not dissolve starch-glucose.

Methylic alcohol at 50°, saturatad with starch-sugar, gives a solution of specific gravity = 1·25. 100 c.c. of methylic alcohol at 50° dissolves 57 grms. of dry starch-sugar, the volume of the solution being 133 c.c. A solution of starch-sugar in ethylic alcohol does not answer so well, because ethylic alcohol does not dissolve so readily the gummy matters found in soft sugars, which are those generally chosen for adulteration with glucose.

To test the presence of starch-sugar in a commercial cane-sugar, the suspected sugar should, in the first place, be thoroughly dried, as otherwise any water present will weaken the alcohol, and enable it to dissolve more starch-sugar. It should then be stirred for about two minutes with the saturated solution of starch-sugar in methylic alcohol. After this, the residue is allowed to settle, and the clear solution poured off. The residue may then be washed with a fresh quantity of the same solution. After stirring again and allowing the residue to settle, there will remain, if any starch-sugar is present, a certain quantity of chalky white specks, accompanied by a fine deposit, formed by the starch-sugar present in powder or fine grains. These finer particles are never seen when water is used for detecting the presence of starch-sugar, as they dissolve in water very readily. It seems probable that by using this solution of starch-sugar in weak methylic alcohol, the starch-sugar in an adulterated sample could be estimated quantitatively by a process somewhat analogous to that of Payen for estimating cane-sugar.

Not having had any occasion for such a process I have not determined experimentally the degree of approximation obtainable in this way.

The methylic solution of starch-sugar should be poured on a filter, after it has dissolved all it can from a commercial sugar, and the residue should be washed out with the same solution, and everything poured on a weighed filter. After all the liquid has run off, the filter and the residue may be rapidly washed with the strongest methylic alcohol found in commerce, which tests 92½° by Gay-Lussac's alcohometer, and which dissolves starch-sugar with great difficulty.

By a dexterous use of this process it seems probable that very approximate results may be obtained, although what is said here is merely in the nature of a suggestion to those who may have use for quantitative results.

* A paper read before the American Chemical Society, Nov. 4, 1880.
† Chemical News, vol. xli., p. 221; *Journal of the American Chemical Society*, vol. ii., p. 111; *Sugar-Cane*, vol. xii, p. 283.

A TUBULATED CRUCIBLE FOR USE IN ESTIMATING VOLATILE PRODUCTS OF IGNITION.*

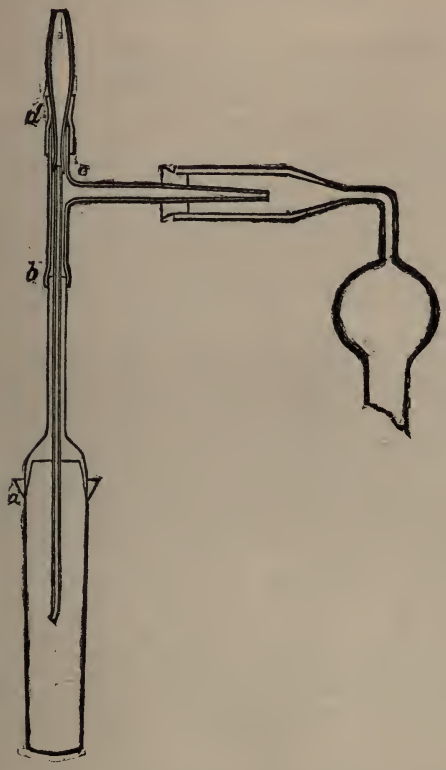
By F. A. GOOCH.

In many processes of analysis which involve the collection and direct estimation of volatile products of ignition (such, for example, as the determination of carbon in irons and steels, or of carbon and hydrogen in organic compounds), the use of combustion-tubes of glass or porcelain or platinum, either with or without boats of platinum or

* *American Chemical Journal*, vol. ii., No. 4.

porcelain as accessories, in connection with proper absorption apparatus, is attended with satisfactory results; but accuracy in processes of this kind which require the application of high temperatures, particularly when the substance under examination is submitted to ignition in contact with a flux or other reagent (as, for instance, in Lipôcz's method of determining the water of constitution of silicates by fusion with sodic carbonate) is not easily secured. It is for use in such processes that the apparatus whose description is appended was devised. Its practical working has been found to be satisfactory, its management easy, and the results of analysis accurate. Its range of applicability to processes, both actual and prospective, whose object is the determination of volatile products of ignition, promises to be extensive.

A platinum crucible shaped, as shown in the figure, in the form of two truncated cones placed base to base, has



its upper rim folded twice upon itself so as to present a smooth conical surface on the exterior and an up-turning flange. A conical cap of platinum prolonged upward in a tube fits the outer surface of the crucible near the flange, *a*, in a ground joint. Over the upper end, *b*, of the platinum tube one end of a T-tube of lead glass is fused, and the other end of the same branch of the T-tube is connected by means of a piece of rubber tubing, *d*, with a glass tube into whose lower end, *c*, is fused a slender platinum tube which extends downward into the crucible and terminates in a slight turn to one side; or, in special cases in which the use of a rubber joint is not permissible, the connection between the inner and outer tubes may be made by fusing the slender platinum tube directly into the upper end of the T-tube. The horizontal branch of the T-tube is drawn out a little and passes through the stopper of an absorption-tube, as shown in the figure. An air-tight joint is made between the cap and the crucible by melting into the flange some easily fusible material like the neutral anhydrous sodic tungstate, or sodic meta-phosphate, the former being preferable in most cases; but the seal may be varied, of course, according to the nature of the case in hand.

In using the apparatus the substance to be ignited is put into the crucible, the cap is adjusted, the inner tube set in place and the rubber joint made, the horizontal branch of the T-tube connected with the absorption apparatus, the opening in the upper end of the inner tube closed by a cap made of rubber tubing stoppered with a bit of glass rod, and finally the seal melted into the flange with a blowpipe-flame.

As the apparatus now stands it should be air-tight. Next, the cap is removed from the top of the inner tube, and the latter connected with an arrangement for forcing (or drawing) pure air or other gas, according to the purpose of the experiment, through the crucible and absorption-tubes, and heat is applied to the crucible. The temperature may be raised until the lower part of the crucible shows a white heat without fusing the seal of sodic tungstate within the flange.

To take the apparatus to pieces after the completion of the operation it is only necessary to disconnect the absorption apparatus, remove the inner tube, re-melt the seal, and lift the cap. Hot water removes the adhering sodic tungstate very easily.

Some of the dimensions of the particular apparatus which I have in use are as follows:—

Capacity of crucible	22·0 c.m.^{3}
Diameter of crucible at top	1·6 c.m.
,, ,, ,, flange	1·9 ,,
,, ,, ,, bottom ..	1·7 ,,
Height of crucible without cap ..	9·0 ,,
,, ,, tube above cap	5·0 ,,
Diameter ,, ,, ...	0·6 ,,
Length of inner tube of platinum ..	13·0 ,,
Diameter ,, ,, ,, ..	0·2 ,,
Weight of platinum in apparatus ..	48 grms.

THE FOG QUESTION.

A new phase of what is called "Sanitary Reform" has just been brought forward. We have been told that the fogs of London and of our other large cities are a nuisance, and though the news is somewhat of the stalest we are listening as if to some novel revelation and beginning to look out for a remedy. Here, therefore, arises a danger lest in our well-meant endeavours to get rid of fog we bring down upon ourselves even greater evils.

The favourite proposal at present is "smoke-consumption," as it is called. It is suggested that "if local authorities had the power to levy a tax upon every fireplace so constructed as not to consume its own smoke, the smoke nuisance would disappear in a very few years." Now we do not for a moment dispute that the normal city fog, yellow or black in its colour, owes most of its disagreeable attributes to the products of the combustion of coal. But will smoke-consumption free us from all these evils? The irritating effects of a dry fog upon the eyes and the mucous membrane of the nose, &c., is admittedly due to the evolution of sulphurous acid derived from the oxidation of the sulphur present in all coal. No smoke-consumption can free us from this unwelcome gas. On the contrary, the more completely every particle of coal is burnt the more certain we are that all its sulphur will be converted into sulphurous or sulphuric acid. We have known manufacturing establishments where nothing but colourless transparent vapour escaped from the chimneys, but the condition of vegetation in the neighbourhood, and the acid reaction of water in which the leaves of adjacent trees had been steeped, showed but too plainly that the enemy was not less formidable because no longer perceptible. So long as we burn the same quantity of coal within the metropolitan area so long, in calm and cold weather, we

shall have a suffocating atmosphere. The only true remedy for this evil is to obtain from coal its practical maximum of duty, and thus immensely to decrease its consumption. Now it is exceedingly doubtful whether any kind of firegrate or stove exists which will answer both these purposes combined. To minimise the quantity of coal needed to heat our houses, the German or Dutch fire-clay stove, with its winding flues which enable the combustion gases to expend almost their entire heat before entering the chimney, are probably the best contrivances known. We are glad to find that Dr. Alfred Carpenter, in his paper read before the Society of Arts, urges that fire-clay should supersede iron in all possible parts of a fire-grate. But though these stoves greatly decrease the consumption of coal, they are not necessarily smoke-consuming, and might very possibly not be accepted by the smoke inspectors who in due time are to lord it over our homes and hearths. On the other hand, many smoke-consuming appliances which we have seen assuredly do little towards diminishing the quantity of fuel required, and the consequent amount of sulphurous acid given off. A charge brought by Dr. A. Carpenter against coal-smoke is the following :—"It is a main factor in the production of a high rate of mortality arising from the absence of ozone, or of ozonised oxygen, or depreciation of oxygen capable of acting upon changing organic matter." That the absence of ozone involves a high rate of mortality is an unproved assertion, nearly all the observations that have been made on the subject being inconclusive. Moreover, it can be experimentally proved that ozone irritates the organs of respiration, the very parts chiefly affected by our town fogs. Statistics do not warrant the inference that "zymotic" disease is promoted by coal-smoke. It is even probable that containing as it does coal-tar products and traces of carbolic and cresylic acids it may act as a disinfectant.

There seems to us an obvious difference between dwelling-houses and factories which ought to be considered before applying the Smoke Prevention Act to the former. A factory, if not the freehold of the occupant, is generally held under a long lease. Hence the occupier may with obvious fairness be called upon to undertake such structural alterations as the public good seems to require. But in a dwelling-house the tenant has in a large majority of cases no permanent interest. It is scarcely compatible with justice to compel a man either to submit to a tax which is in reality a penalty or to sink perhaps more than a year's rent in altering the fire-grates of a house which he may have to quit at six months' notice, and perhaps to repeat the outlay in another dwelling! Then there is the pleasant prospect that the inspector may be induced by dealers in stoves to pronounce the arrangements for smoke-consumption unsatisfactory, and the expense and the trouble will have to be incurred afresh! In prospect of such things we believe that all save the wealthy will prefer to run the risk of bronchitis rather than the certainty of being harried for the carrying out of this new sanitary reform.

There is one cause of smoke and general nuisance which has sprung up of late in all the outskirts of London which have a clay sub-soil, namely, "ballast" burning. This is carried on in the northern suburbs in the most high-handed manner and quite close to dwelling houses. A ballast heap gives off more smoke than a hundred dwelling-houses. Such smoke, too, is far worse in quality. The poorest coal mixed with the contents of the dust-bins serve for fuel, and as the heat is never fierce, the volatile products are not decomposed but escape into the atmosphere. In certain states of the weather, a plot of land of hundreds of square yards may be seen completely shrouded by the smoke and vapours from a single heap. This nuisance should be the first evil to be suppressed in the endeavour to improve the atmosphere of London. Next, sharper attention should be paid to locomotives, steamships on the river, and the portable engines used by building speculators and others, many of which dispense clouds of black smoke without any interference. It might be fairly enacted that all houses built after a certain date should be fitted with some improved fire-grate, and that other houses on the expiration of a tenancy should be reformed before being let again. Now the appliances for the use of gas as a fuel have been so greatly improved by certain inventors, among whom Mr. Fletcher, of Warrington, may claim the foremost place, it is very certain that cooking by gas would increase greatly if the price were reduced. It strikes us that the gas companies would find in this respect liberality the best policy, since lower charges would lead to a vastly increased consumption.

CORRESPONDENCE.

THE SPECIFIC ROTATORY POWER OF CANE- AND INVERT-SUGAR.

To the Editor of the Chemical News.

Sir,—In the Chemical News, vol. xlii., p. 257, is a communication of Mr. J. Steiner on "The Specific Rotatory Power of Cane- and Invert-sugar," which is interesting from the fact that he understands his subject and states his points with clearness. I must, however, take exception to the following passage, which contains erroneous statements :—"Clerget found that 16·35 grms. of pure sugar after inversion, and cooling to 0° C., deviate the light to −44 divisions of Soleil's scale. Tuchschmidt, by a series of careful observations, confirmed this (finding −44·16), and Casamajor merely repeated partly what Tuchschmidt had said before him."

I have not before me the paper of Clerget in the *Annales de Chimie et de Physique*, but I have the impression that Clerget's experiments did not extend any lower than 10°. Dr. Tuchschmidt does mention, however, that at 0°, −16·471 grms. of sugar in 100 c.c., when inverted, will give −44. This number, −16·471, is the one used in Soleil's old instrument. At any rate, by calculating from Clerget's table what the deviation would be at 0, we find −44.

Dr. Tuchschmidt found that the law is expressed by $-44{\cdot}16+0{\cdot}50578\,t$ instead of $-44+\frac{t}{2}$. This may seem a confirmation of Clerget's results, and I have shown that for temperatures between 10° and 40° C., the results of both formulæ are nearly the same. For higher temperatures, the differences are quite appreciable. For the temperature at which the deviation becomes 0, the formula $-44+\frac{t}{2}$ gives 88° C., while Tuchschmidt's formula gives 87·3° C. I have ascertained experimentally that 88° C. is the correct temperature.

As to my own labours, it is an error to state that I merely repeated partly what Dr. Tuchschmidt had said before me. If Mr. Steiner will take the trouble of reading my paper and that of Dr. Tuchschmidt, he will see that he is entirely mistaken. In order to present my results with clearness, I was obliged to go over the whole subject, and Dr. Tuchschmidt's paper contains some things which are also in mine. At the time of writing my paper, I was not aware of the results of Dr. Tuchschmidt, which were called to my attention by Dr. Behr, and I noticed them in a foot note.

The object of the researches which I undertook on the deviation of inverted sugar, as affected by temperature, was beyond the range of the labours of either Clerget or Tuchschmidt. My object was to ascertain experimentally at what temperature the deviation of inverted sugar becomes 0. In the books this temperature is given as 90° C., and one experimenter has placed it at 92° C. If either of these numbers was correct, the law deduced from

Clerget's table, which gave 88° C., must suffer a change above 35° C., which was the highest temperature observed by Clerget. Was there such a change, and, if there was, at what temperature did it occur? I determined the deviations due to inverted sugar, and gave the results of 68 observations, made between 14° and 92° C. The result of these was that the law deduced from Clerget's table was found correct all the way to 92°. The deviation at 88° was found to be 0, and at 92° it was +2. Previous to these researches, the deviations above 41·8° (the highest temperature observed by Tuchschmidt) had not been investigated, except that the statement was made that the deviation of inverted sugar became 0 at 90° or 92°. Nobody had inquired whether this had anything to do with the law contained in the table of Clerget.—I am, &c.,

P. CASAMAJOR.

Brooklyn, December 7, 1880.

THE THALLEIOQUIN TEST AGAIN.

To the Editor of the Chemical News.

THE very spirited defence of the claims of H. A. Meeson as put forward by J. Denham Smith in the CHEMICAL NEWS, vol. xlii., p. 183, as discoverer of the thalleioquin test, require some explanation at my hands. When such authority as your Henry Watts, B.A., F.R.S., F.C.S., author of probably the best chemical dictionary in the English language, should be so woefully ignorant of the claims of this Guy student as not to give him credit for the discovery in his article on Quinine, and yet possibly breathing the atmosphere of the same city, is it marvellous that a writer over 3000 miles away should be *beguyled* into following the common herd and awarding the palm to the Frenchman? The fact is that the writer has never had the pleasure of M. André's acquaintance, and it is *just possible* that M. André may be ignorant of the existence of the writer. Under the circumstances, it would be as great a presumption for him to accept the office of scientific executor as for Mr. Smith to tender it. The facts, however, as set forth by Mr. Smith, are sufficient to establish the priority of Meeson's claim, and unless another applicant appears claiming still greater priority, this leaf shall undoubtedly be restored to his chaplet.—I am, &c.,

CHAS. FREDK. ZELLER.

Philadelphia, December 11, 1880.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade, unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, l'Académie des Sciences. No. 22, November 29, 1880.

Note Relative to a Memoir on the Vision of Material Colours in Rotatory Motion and of Speeds estimated in Figures by means of General Morin's Apparatus named the "Turning Plate" for the Observation of the Laws of Motion.—M. Chevreul.—This note is substantially an expression of regret for the delay in the appearance of the memoir in question.

Spontaneous Oxidation of Mercury and of Metals.—M. Berthelot.—Mercury, as well as iron, zinc, cadmium, lead, copper, and tin, undergoes on exposure to the air a superficial oxidation, very slight, and restricted by the difficulty of renewing the surfaces and by the want of contact which results from the layer of oxide formed at the outset. For the oxidation to continue this layer must be constantly removed, as is the case with rust of iron formed in moist air, or for lead hydrocarbonate produced in distilled water.

Propagation of Light.—M. Gouy.—The author shows that there is not for a given homogeneous source a determined speed of light independent of the manner in which the amplitude is caused to vary.

A New Electric Property of Selenium, and the Existence of Tribe-electric Currents Properly so-called.—R. Blondlot.—The author has observed a new electric property of selenium which may be shown by the following experiment:—To one of the poles of a capillary electrometer there is attached, by means of a platinum wire, a fragment of selenium which has been recently heated, and to the other pole a platinum foil. If the selenium is brought in contact with the platinum, holding it by means of an isolating handle, the electrometer remains at zero, as might be expected from the symmetry of the circuit; but if the selenium is rubbed against the surface of the metal the electrometer deviates strongly, the deviation obtained being equal to that produced by a sulphate of copper element.

Action of Phosphorus upon Hydriodic and Hydrobromic Acids.—A. Damoiseau.—With hydriodic acid and white phosphorus the latter melts and becomes covered with a reddish layer of biniodide, whilst phosphonium iodide sublimes. With red phosphorus even at 100°, there is produced merely a small quantity of phosphonium iodide. Upon dissolved hydrobromic acid, phosphorus does not react in the cold. At from 100° to 120°, phosphonium bromide sublimes, but no phosphorus bromide is produced.

On Waldivine.—C. Tanret.—Waldivine, $C_{36}H_{24}O_{20}$, is a neutral principle, without rotatory power, very sparingly soluble in cold water, freely soluble in chloroform, insoluble in ether, and remarkable for the ease with which it is decomposed by alkalies.

Proximate Analysis of Peat: Its Chemical Constitution.—C. E. Guignet.—Peats contain the acids formerly known as crenic and apocrenic, a waxy matter, soluble in benzine, a quantity of paraffine, chlorophyll, and certain glucosides.

Certain Optical and Visual Phenomena.—M. Trève.—If the flame of a lamp is viewed through a narrow slit, the lustre of the flame and the effects of diffraction vary much according as the slit is vertical or horizontal, the light being much more considerable in the latter case.

Revue Universelle des Mines, de la Metallurgie, &c., Tome 7, No. 2, March and April, 1880.

Distribution of Copper in Primordial Rocks and Sedimentary Deposits.—L. Dieulafait.—Noticed under the *Comptes Rendus.*

Australian Guanos.—A report on the guano of the islands Malden, Lacépède, and Huon. These guanos are poor in potash and nitrogen, but rich in phosphates.

Analysis of Superphosphates.—L. Chevron.—In acting upon a superphosphate made from bone-black or from the phosphate of Caceres with a solution of ammonium citrate of sp. gr. 1·09, there is no occasion to take into account the time of action or the fluctuations in the temperature of the laboratory. In the analysis of a bone-black superphosphate, an excess of citrate must be avoided—20 c.c. are sufficient for 2 grms. of the sample. An excess of the reagent dissolves part of the phosphoric acid of such tricalcic phosphate as has escaped the action of sulphuric acid in the manufacture of the superphosphate. The phosphate of Caceres is much less sensitive to the action of the citrate than the phosphate of bone-black, and here from 20 to 100 c.c. may be taken to 2 grms. of the sample.

Tome 7, No. 3, May and June, 1880.

This issue contains no original chemical matter.

Tome 8, No. 4, July and August, 1880.

This issue contains no papers on chemical subjects.

Bulletin de la Société d'Encouragement pour l'Industrie Nationale.

No. 78, June, 1880.

Report Delivered by M. F. Le Blanc on an Apparatus for the Industrial Analysis of Gases Invented by M. H. Orsat.—This useful apparatus cannot, unfortunately, be intelligibly described without the two accompanying figures.

Report Delivered by M. F. Le Blanc on M. Coquillon's Apparatus for the Rapid Determination of Fire-damp in the Atmosphere of Mines.—This paper also cannot be reproduced without the accompanying illustration.

No. 79, July, 1880.

The Society has awarded the Le Blanc prize of 1000 francs for the utilisation of manufacturing refuse to M. Vincent, for his process for obtaining methyl chloride from the *vinasses* of the beet-root sugar manufacture.

A sum of 1000 francs has been awarded to M. J. A. Martin for his mixtures for rendering textile articles, paper, &c., uninflammable. His ordinary mixture for light goods is :—Pure ammonium sulphate 8 kilos., ammonium carbonate 2 kilos. (5), boric acid 3, pure borax 2, starch 2 (for which may be substituted 0·400 kilo. dextrine, or the same weight of gelatine), and water 100 kilos.

A silver medal has been awarded to M. Idrac for his process of drying timber.

Les Mondes, Revue Hebdomadaire des Sciences.

No. 9, July 22, 1880.

New means of Rendering Tissues Water-proof.—The process consists in passing the tissues under a press containing a "peculiar composition" which is kept secret. Cloth, paper, &c., thus made water-proof remain permeable to air.

No. 10, July 29, 1880.

It appears that more than a third part of the vines in France have been already destroyed by the phylloxera. The departments of Haute Savoie and Jura are now attacked.

Determination of Chicory in Ground Coffee.—M. Prunier.—The author weighs out 2 grms. and separates the finer powder by sifting through fine silk. This powder which, as microscopic examination proves, is composed entirely of pure coffee, is set aside. That which remains on the sieve is macerated with a few grms. of water in a test-glass. After some hours it is thrown upon a piece of cloth stretched out and crushed with the fingers. The grains of coffee resist the pressure, whilst those of chicory reduced to a paste by soaking in water, penetrate into the cloth, and adhere to it. On drying the cloth it is easy to detach the coffee, which, after desiccation at 100° and addition of the fine powder separated at first, gives the weight of pure coffee. The chicory is calculated as loss.

No. 12, August 12, 1880.

The Marquis Tommasi has succeeded in sending a message across the Atlantic with two Minotto elements.

An Application of Accidental Images.—J. Plateau.—The author, from some experiments performed by his son, concludes that the *apparent* distance of the full moon is only 50 metres from the observer.

No. 13, September 2, 1880.

"Floral Manure."—This compound, which is said to consist of nitrogen, phosphoric acid, magnesia, and sulphur in a very concentrated state, is said to have given, in experiments made at Saint Ouen, results superior to other manures, though it was applied to pure sand and its rivals to garden soil. It is applied in solution, 1 or 2 grms. to a litre of water.

A New Electric Motor and its Applications.—M. Trouvé.—The description would not be intelligible without the six accompanying illustrations. Referring to an experiment to be made with this apparatus by MM. Trouvé and Gaston Tissandier, M. Moigno makes the characteristic remark :—"I shall not be present; the cassock of the author of the "Splendeurs de la Foi" would distress M. Gaston Tissandier too much!"

The Electrophone.—L. Maiche.—An illustrated memoir.

Researches on the Property which Solid Bodies Possess of becoming Soldered together by means of Pressure.—W. Spring.—This property appears to be a function of hardness, but appears to depend also on another element. All crystalline bodies unite easily. Amorphous bodies are divided into two groups, the ciroids —wax, pitch, &c.—which become welded together by pressure, and the aciroid, such as amorphous carbon, which cannot.

Certain Properties of Flames.—M. Neyreneuf.—Already noticed.

No. 14, September 9, 1880.

Fire- and Water-Proof Paper.—There is prepared a mixture of two-thirds ordinary paper pulp, and one-third asbestos. The whole is then steeped in a solution of common salt and alum, and after being made into paper is coated with an alcoholic solution of shellac.

Tome 53, No. 1, September 16, 1880.

Resistance of the Air.—A discussion concerning a paper by M. Le Dantec (*Mondes*, Sept. 1).

Study on the Gramme Machine.—M. Pelleux.—The first portion of a memoir, to be completed in a succeeding number.

No. 2, September 23, 1880.

This number does not contain any chemical matter which has not appeared elsewhere.

No. 3, October 14, 1880.

M. Maiche informs the editor that his electro-electrophone speaks through resistances equal to 20 million kilometres, and that he can cause an ordinary telegraph to act against these prodigious resistances.

Disinfection of Animal Matters, Blood, &c.—M. Vautelet.—The author proposes a treatment with aluminium sulphate, sulphuric and nitric acids, used in certain proportions,—a process efficacious, but certainly not novel.

Reimann's Färber Zeitung,

No. 25, 1880.

This issue contains a notice of the trade list of the Urda Company of Stockholm, who offer ammonium vanadiate at the greatly reduced price of £15 per kilo.

Sodium phosphate is recommended by Dr. Allrich as useful in dyeing with the new azo-colours. It is added to the extent of 4 per cent of the wool to be dyed along with the neceesary colouring-matter in water of 30° to 35°, and after the yarns have been turned for about ten minutes and taken out, alum is added to the extent of 6 per cent, the yarn is re-entered, and the water slowly raised to a boil.

No. 26, 1880.

This number contains an account of the Exhibition of the German Woollen Trade, at Leipzig.

No. 27, 1880.

With reference to the Sidney Exhibition it is mentioned that the firm Laer and Son, who received the first prize

for woollen yarns, are not manufacturers at all, but merely buy yarns and send them to be dyed or printed!

No. 28, 1880.

This number is principally devoted to an account of the Leipzig and Dusseldorf Exhibitions.

No. 29, 1880.

At a meeting of the Société Industrielle of Mulhouse, it was stated that tin sulphocyanide, formed by the double decomposition of calcium sulphocyanide and tin oxalate, is found very useful in calico printing.

E. Dollfus, on treating the diazo-derivative of ortho-toluidine with nitric acid, obtained a binitro-cresol, which melts at 86° and crystallises in yellow needles. It is distinct from the two binitro-cresols which have been examined by Martius and Wichelhaus.

No. 30, 1880.

M. A. Poirrier, of Paris, writes that the azo-colours, orangé, rocceline, chrysoine, and ponceau, were first discovered by Roussin, who deposited an account of his researches in a sealed packet in the care of the Academy of Sciences, April 8, 1876.

For printing cotton with the azo-colours, Dr. Allrich proposes to dissolve 100 grms. of the colour in five times its weight of water; then makes up a solution of sodium stannate or aluminate at 15° B., to every litre of which are added 20 grms. alizarin oil. Of this mixture 150 grms. are incorporated with the colour, which is then thickened with starch and printed. After printing the pieces are steeped for an hour in lead or barium acetate or barium chloride at 5° to 10° B., and washed in cold water.

Chemisches Central-blatt.

No. 24, 1880.

Influence of Increased Supplies of Water on the Transformation of Matter in the Animal System.—Jacques Mayer.—Augmented excretion of nitrogen does not accompany augmented excretion of water.—*Med. Central Blatt*, 18, p. 276.

Detection of Arsenic in Non-metallic Liquids.—H. Hager.—The author recommends his process for evolving arseniuretted hydrogen, and bringing the gas in contact with paper moistened with silver nitrate.

Determination of Silicon in Iron and Steel.—T. M. Brown.—One grm. iron or steel is placed in a porcelain crucible with 25 c.c. nitric acid of 1·2 sp. gr. When the reaction is over 25 to 30 c.c. dilute sulphuric acid—1 part acid and 3 water—are added, and the solution is heated till the nitric acid is entirely or nearly expelled. When the residue is sufficiently cool water is cautiously added, and the contents of the capsule are heated till the crystals are perfectly dissolved. The solution is then filtered as hot as possible, and the residue washed first with hot water, then with 25 to 30 c.c. hydrochloric acid of sp. gr. 1·20, and finally again with hot water. After drying and ignition the silica is obtained snow-white and granular.

Contribution to Electrolysis.—L. Schucht.—The author describes the electrolytic determination of unanium, thallium, indium, vanadium, palladium, molybdenum, selenium, and tellurium. For qualitative analysis he uses a strong test-glass, 10 to 12 c.m. high, and 1·5 c.m. wide, fitted with a cork coated with paraffin. Two platinum wires, 1½ m.m. in thickness, pass through the cork down to the bottom, and are connected above the cork with the polar wires of the battery by means of small binding screws. This decomposition tube may be held in a wooden clamp. After the current has passed through the solution to be analysed for ten to fifteen minutes, the stopper with the wires is drawn out, without interrupting the current, and the deposited metal is determined by its colour, lustre, solubility in acids, &c. The manner of decomposition and the slight or strong evolution of gas is noticed. The solution is completely precipitated, rendered alkaline, and again electrolysed, after the wires have been cleansed. Copper is recognised by its colour, mercury by the precipitated globules, nickel and cobalt by their lustre and sparing solubility in acids, zinc and cadmium by their colour and solubility in potassa. The formation of peroxides is characteristic for lead, silver, bismuth, thallium, manganese. Bismuthic acid is gradually formed, whilst the peroxides of lead, silver, and thallium are deposited at the beginning of the precipitation. Silver peroxide dissolves in ammonia with liberation of nitrogen. The decomposition of the alkalies and alkaline earths is best effected in a U-tube. The hydroxides of the latter are separated in a voluminous form; those of calcium and magnesium in white crusts. The hydroxides of barium, stontium, and the alkalies dissolve on the negative wire.—*Berg- und Hütten Zeitung*, 39, 121.

Determination of Gold and Silver in Alloys, after Quartation with Cadmium.—Fr. Kraus.—Two portions of the alloy, each of 0·25 grms., are weighed off and placed with the cadmium in small porcelain vessels. A piece of potassium cyanide is melted in a porcelain capsule over the flame, and the metal thrown in. The melting together takes place readily, and is complete in a few minutes. By changing with two or three porcelain capsules, and having a vessel with warm water at hand, in which the melt is dissolved when sufficiently cool, twenty to thirty meltings can be executed in an hour. The two metallic granules are now thrown together into a small long-necked flask, in which is nitric acid of sp. gr. 1·30; a piece of wood charcoal is introduced to prevent bumping—which would rupture the globules—and heat is gently applied. The first solution lasts rather long, according to the proportion of gold; *e.g.*, an hour in case of fine gold. The solution is poured off, the boiling repeated with nitric acid of sp. gr. 1·3 for ten minutes, the liquid again poured off, the globules rinsed with hot water, boiled for five minutes with water, which is poured off, and the flask filled with water is inverted into a porous earthern crucible, dried, ignited strongly, proceeding as in cupellation. In most cases the globules can be weighed separately. Silver is determined in the solution of titration with ammonium sulphocyanide according to Volhard's method.

No. 26, 1880.

Preparation of Liquids of Determinate Specific Gravity without the use of Tables of Weight.—E. Mylius.—The author proposes a formula for this purpose.

The Bulk of Yeast-Cells as a Factor in Natural Degeneration.—J. Brynych.—The smaller yeast-cells are much more liable to disease than the large ones.—*Listy Chem.*, 4, 229.

Annales de la Société des Sciences Industrielles de Lyon,

No. 2, 1880.

This number, contrary to what might have been expected, does not devote a line to dyeing, tissue-printing, or the manufacture of colours, and in fact contains no chemical matter at all.

No. 3, 1880.

This number, again, contains no reference to the chemical arts and manufactures.

MEETINGS FOR THE WEEK.

Monday, 3rd.—London Institution, 5.
Tuesday, 4th.—Royal Institution, 3 p.m. "Atoms," Prof. Dewar.
Wednesday, 5th.—Geological, 8.
Thursday, 6th.—London Institution, 7.
—— Royal Institution, 3. "Atoms," Prof. Dewar.
—— Royal, 4.30.
Friday, 7th.—Geologists' Association, 8.
Saturday, 8th.—Royal Institution, 3. "Atoms," Prof. Dewar.

THE CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE.

Edited by WILLIAM CROOKES, F.R.S.

Published every Friday. Price 4d. Annual Subscription, post free including Indices, £1

CHARGES FOR ADVERTISEMENTS.

	£	s.	d.
Five lines in column (about 10 words to line)	0	3	6
Each additional line	0	0	6
Whole column	1	15	0
Whole page	3	0	0

A reduction made for a series of insertions.

Cheques and Post-Office Orders, crossed "London and County Bank," payable to the order of William Crookes.

BOY COURT, LUDGATE HILL LONDON, E.C.

MR. J. S. MERRY,

ASSAYER AND ANALYTICAL CHEMIST,

SWANSEA.

BERNERS COLLEGE of CHEMISTRY.

Instruction and preparation in CHEMISTRY and the EXPERIMENTAL SCIENCES under the direction of Professor E. V GARDNER, F.A.S., M.S.A.

The Class Rooms are open from 11 to 5 a.m. and from 7 to 10 p.m daily.

Especial facilities or persons preparing for Government and other examinations.

Private Pupils will find every convenience.

Analyses, Assays, and Practical Investigations connected with Patents, &c., conducted.

Prospectuses and full particulars on application to Prof Gardner at Berners College, 44, Berners-street W.

BISULPHITE OF LIME.

BISULPHITE OF SODA.

ULPHITE OF SODA. TANNATE OF SODA.

WILLIAM MARRIOTT

CHEMICAL WORKS, HUDDERSFIELD

MOTTERSHEAD & CO.,

7, Exchange Street and 10, Half Moon Street,

MANCHESTER.

CHEMICAL & PHYSICAL APPARATUS,

BOTTLES, PURE CHEMICALS,

REAGENTS, STANDARD SOLUTIONS,

And Every Requirement for Works' or School Laboratories or Private Students.

Illustrated Price Lists on application.

Water-Glass, or Soluble Silicates of Soda and Potash, in large or small quantities, and either solid or in solution, at ROBERT RUMNEY'S Ardwick Chemical Works, Manchester.

Wanted, to Purchase Volumes 1, 3, 5, 6, and 7, of the "Journal of the Chemical Society"; also Vol. 3 of the "Proceedings of the Royal Society."—Address, K. P. G., CHEMICAL NEWS Office, Boy Court, Ludgate Hill, London, E.C.

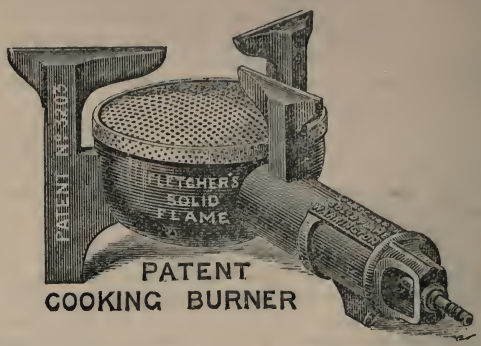
ROYAL POLYTECHNIC.—Utopia, a Grand Fairy romance. The Electrical Railway; Great Lightning Inductorium; a Lecture on Scientific Wonders, by Mr. J. L. King. Musical Sketches, by Mr. Eric Lewis. Christmas and its Customs, by Mr. Frank Heath. Humorous Recitals, by Madame Hickson. Blondin, Leotard, Diving Bell, &c. Admission to the whole, 1s. Open from 11 till 5, and from 6 till 10.

FLETCHER'S

PATENT SOLID FLAME BURNERS.

The Highest Power Gas-Heating Burners ever constructed.

Improved pattern, with Perforated Copper Dome, for dirty work. PRICE, Japanned, 6s. 6d.; Nickel Plated, 8s. 6d.

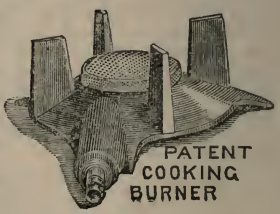


Will do any work, from the smallest to melting a hundredweight of lead in an iron pot. Will boil 2 quarts of water in a flat copper kettle in 6 minutes.

Smaller size, for general use with a poor gas supply, slightly under half the power. Japanned, 4s.; Nickel Plated, 5s. 6d.

Illustrated List of Gas Apparatus for Domestic Use (Cooking, &c.) free by post.

Illustrated List of Gas and Petroleum Heating Apparatus for Laboratory use; Furnaces, Foot and Automatic Blowers, Hot and Cold Blast Blowpipes, Ingot Moulds, &c., Price 2d.

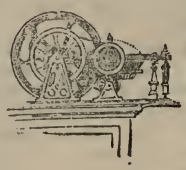


THOS. FLETCHER,

4 & 6, MUSEUM STREET, WARRINGTON.

Carr's Patent Paint and Drug Mill.

Approved by some of the most eminent Chemists, and awarded the Silver Prize Medals of the Manchester and Liverpool, and the Middleton Agricultural Shows.



From Messrs. E. H. SMYTH & Co., 21 Duke Street, Edinburgh, and 69, Coleman Street, City, London.—The small Levigator Mill we recently got from you works most efficiently, and is a great economiser of time.

The chief feature in this machine is, that although it can be turned with ease by a boy, it has immense frictional power for levigating purposes. This is caused by the runner being driven at a much greater speed, but in the same direction, than the bowl. The surfaces being Minton ware, they are clean, smooth, and durable.

Testimonials on application.

£11 nett cash, delivered in Manchester.

The diameter of the bowl is 18 ins., and it and the runners are made of Minton ware. It is useful for Painters, Chemists, Grocers, and Cooks, for triturating and mixing Medicines, Vegetable Powders, Ointments, Paints, Sugar, Salt, Spices, Herbs, Meat for Potting, and will grind the COARSEST EMERY INTO A NEARLY IMPALPABLE POWDER in a few seconds. The pan can be tilted for emptying, as shown in the dotted lines; it can be worked by hand or power.

SOLE MAKERS—

W. H. BAILEY & Co., Albion Works, Salford, Manchester.

ASBESTOS.

H. W. JOHN'S MANUFACTURING CO. have appointed WITTY and WYATT Sole European and Colonial Agents for their well known ASBESTOS Fire-proof Paints and other materials, which for twenty years have been largely used in the United States, South America, China, Japan, &c.

ASBESTOS RETORT CEMENT is Fire- and Acid-Proof; when subjected to intense heat will vitrify without shrinking, thus rendering it of great value in repairing retorts, pipes, and other chemical appliances.

INDEX.

"ABERDEENSHIRE Agricultural Association Report" (review), 232
Acetic acid and sodium hyposulphite, refraction indices of aqueous solutions of, 184
Acetic ether, continuous method of preparing, 72
Aceto-benzoic anhydride, 166
Acetyl chloride and titanium chloride, a compound of, 166
Acichlorides, molybdic, 13
Acid, arsenious, quantitative determination of in the presence of arsenic acid, 222
boro-deci-tungstic, and its sodium salts, 210, 221
cinchomeronic, 186
citric, synthesis of, 12
concentrated sulphuric, action of on lead, 314
digallic, 36
disulpho-phenanthrenic, 109
gases, injury to vegetation from, 36
gluconic, 186
hybromic, etherification of, 35
hydrocyanic, so-called spontaneous decomposition of, 73
malonic, electrolysis of, 166
preparation of, 13
myristic, derivatives of, 84
meconic, double salts of, 75
phosphoric, in wine, 85
manufacture of, 282
reverted, 118
volumetric determination of 306
picric, detection of in beer, 259
phytolaccic, 317
reaction of animal tissues after death, 164
salicylic, action of woody fibre upon, 120
new reaction for, 49
sulphuric, etherification of, 83
tartar and tartaric, in must and wine, 84
tropic, artificial formation of, 110
tungstoboric, 209
"Acid, Sulphuric, and Alkali, Manufacture of" (review), 21 22
Acids, action of dehydrating agents upon, 109
complex, containing boric acid, 282
fatty, of butter, 72
of carbon, new synthesis of, 96
phenyl-lactic, 109
ulmic, materials produced by the action of upon sugar, 271
Acorns, nutritive value of, 95
Actino-chemistry, new methods in, 44
Actinometry. slow, simple process of, 178
Action at a distance, 268
Adam, P., and E. Grimeaux, synthesis of citric acid, 12
Adamkiewicz, A., destiny of ammonia in healthy persons, 186
Adams, W. G., Address to the British Association, 157
Ader, M., mechanical effects produced in the magnetic nucleus submitted to an electric current, 48
telephone with magnetic superexcitation, 12
telephonic effects resulting from the shock of magnetic bodies, 83
Africa, South, diamond mine of, 85
"Agricultural Association, Aberdeenshire, Report of the" (review), 232
Agricultural purposes, disinfection and preservation for, 24
Air and the waters, ammonia in the, 83
highly rarefied, heat conduction in, 309
proportion of carbonic acid in the, 13, 24, 35
Air-thermometer, new, 258
Albert H., Dr. Follbrecht, and H. Joulie, behaviour of phosphoric acid in the soil, 35
Albumen, detecting in urine, 210
in plants, 96
Albuminoid matters of the crystalline lens, 12
ferments of the, 270
Aldehyd resin, 186
Aldred, C. H., process for heating mineral substances containing small quantities of phosphate of lime, 177
Alcohol in animal tissues, 186
in ethereal oils, detection of, 318
Alcoholic fermentation, rapid, 197
Alcohols, aluminium, 267
Alimentary substances, falsification of, 165
Alizarin blue, 24
Alkalies, organic, researches on, 95
Alkaline earths, characteristics of, 317
metals, fluorised compounds of uranium with, 95
vapour densities of, 110
polysulphides, thermic study of, 48
solutions of copper and mercury, behaviour of sugar with, 96
zinc oxide in, 30
"Alkali Trade" (review), 22
Alkali waste as a manure, 295
Alkaloids, zinc chloride as a reagent for, 318
Allaire, O., purification and refining of fatty matters, 166
Allen, A. H., petroleum spirit and allied liquids, 189
specific rotatory power of cane and invert sugar, 177, 208, 269
Allihn, F., new process of saccharification, 222
Alloys, determination of gold and silver in, 331
Allrich, Dr., use of sodium phosphate in dyeing, 330
Aloes in elixirs, rapid detection of, 306
Alum, cubic, 110
well, ancient, at Harrogate, 268
Aluminates of potassium and sodium in solution, 29
Aluminiferous superphosphates, ferriferous, reversion of, 90
Aluminium alcohols, 267
and magnesium, gases retained by occlusion in, 318
hydroxide, isomeric modification of, 119
iodine, reaction of, 2
sulphate free from iron, 191, 202
new, 23
Amagat, E.H., compressibility of gases under strong pressure, 209
of oxygen, 294
Amat, L., atmospheric electricity observed in the north of the Sahara, 210
American Chemical Society, 21, 44, 58, 207, 246, 291, 304
pork, insalubrity of, 318
Amides and anilides of oxybutyric acid, 109
Amido-acids, aromatic, 110
Amido-, azo-, and diazo-compounds, constitution of, 237
Amines, ethyl, action of ethyl-chloride upon the, 95
primary, action of benzo-trichloride on, 7
Ammonia, action of monobromated diphenyl-methan upon, 283
and Nessler's reagent, behaviour of carbonic acid with, 259
in healthy persons, destiny of, 186
in the air and the waters, 83
some causes of variation in the precipitation of manganese hydrate by, 259
Ammoniacal gas with palladium chloride and iodide, combinations of, 294
Ammonium compounds, 108
polysulphides, thermic researches on the, 60
Analcime, artificial reproduction of, 35
Analyses of pyrites by the gravi-volumetric method, 20
of some hair-dyes, 8
Analysis of a crystalline salt, 163
of beer, 175
of mixed tissues of silk and cotton, 73
of peat, proximate, 329
of shoddy and wool waste, 325
of soaps, 53
of superphosphates, 329
"Analysis of a Simple Salt, Tables for the" (review), 207
"Analysis, Quantitative Chemical" (review), 82
Andreæ, H., nitro-ortho- and and nitro-para-azo-phenetols, 96
Andrews, L. W., ethylen-iodopictate, 108
Aniline, para-brom-derivatives of, 97
Animal matters, &c., disinfection of, 330
tar, 186
tissues after death, acid reaction of, 164
alcohol in, 186
Animals, distinction between human blood and that of other, 258
Anhydride, aceto-benzoic, 166
sulphuric, evaporation heat of 47
Anhydrous lime, crystalline, 48
Antimoniferous manganese ore, 223
Antiseptic action of salicylic acid, 97
Apiculture at Paris, 211
Aqueous solutions of acetic acid and sodium hyposulphite, refraction indices of, 184
Arc, electric, electromotor force of the, 95
Armstrong, H. E, and W. C. Graham, some derivatives of naphthalene, 243
Arnold, J. O., estimation of chromium in iron and steel, 285
Aromatic amido-acids, 110
arsenical compounds, 20
products of the animal body, 108
Arseniate and lead phosphate in dilute acetic acid, solubility of, 165
Arsenic in non-metallic liquids, detection of, 331
Arsenical compounds, aromatic, 20
Arsenious acid in the presence of arsenic acid, quantitative determination of, 222
Arsenophobia, 36
Art and Science Department Examinations, 135, 166, 176
Artificial indigo, 7
Ash in coal, determination of, 41 in wines, 49
Atacamite and basic salts, 210
Atmosphere, blue colour of the, 305
electricity, 95
observed in the north of the Sahara, 210
Attfield, Prof., testimonial to, 211
Atomic volumes of certain elements, relation between, 171
weight of beryllium, 261, 273
of glucinum, 95
of scandium, 83
of tellurium, 84
of ytterbium, 61
Australian guanos, 329
Azapis, M., improvement in Bunsen's battery, 184

BACTERIA, atmospheric, 61
manufacture of vinegar by means of, 165
Baeyer, A., compounds of phthalic acid with the phenols, 61
Baildon, H. B., "Spirit of Nature" (review), 46
Baker, H., certain cases of isomorphism, 84
fluorine compounds of vanadium, 85
and S. Suguira, magnesium vanadiates, 85
Balbiano, L., amides and anilides of β-oxybutyric acid, 109
Bayley, T., specific rotatory power of cane and invert sugar, 233
Balsohn, M., and C. Friedel, action of bromine upon diphenyl-methane, 72
action of mono-bromated diphenyl-methan upon ammonia, 283
Bases, pyridic, 146
Basic salts and atacamite, 210
Bast fibres, chemistry of, 77, 91
Batteries, 132
Battery, theory of the, 258
Baudrimont, E., action of permanganate upon potassium cyanide, 165
Baumann, E., aromatic products of the animal body, 108
Bayley, T., new form of filter pump, 286
Beard, G. M., "Practical Treatise on Sea-Sickness" (review), 45
Béchamp, A., albuminoid matters of the crystalline lens, 12
formation of chloroform, 294
J., alcohol in animal tissues, 186
Becquerel, H., experimental researches on rotatory magnetic polarisation in gases, 24
Beer analysis, 175
detection of picric acid in, 259
glycerin in, 36
Beers, certain, analysis of, 306
Bees, chemical researches on the activity of, 84
Bees'-wax, tests of, 181
Beet-root sugars, vanillin in, 109
Behrend P., M. Märcker, and A. Morgen, determination of fecula in potatoes, 175
Beilstein, F., and A. Kurbatow, dinitro-benzoic acid, 109
dinitro-para-toluidine, 108
Bell, A. G., application of the photophone to the study of the sun, 270
Bellamy, F., reaction between sulphuretted hydrogen and sodium hyposulphite, 185
Benzo-trichloride on primary amines, action of, 7
Benzol, action of electrolysis upon, 95
fractional distillation of, 183
Benzhydrol and naphthaline, condensation of, 109
Bergmann, F., and H. Fresenius, electrolytic determination of nickel and cobalt, 75
electrolytic determination of silver, 76
Berthelot, M., and M. Ogier, isomerism, 294
basic salts and atacamite, 210
density of the vapour of iodine, 82
thers, 210
evaporation heat of sulphuric anhydride, 47
formation heat of hydrocyanic acid and the cyanides, 83
of the oxides of nitrogen and those of sulphur, 35
heat formation of dimethyl, 293
of the ethers, 270
heat of combustion of the principal gaseous hydrocarbons, 12
part played by time in the formation of salts, 234
Berthelot, M., heats of combustion, 132
preparation of chlorine, 132
relation between the chemical mass of the elements, 47, 60
researches on organic alkalies, 95
solution of chlorine in water, 119
spontaneous oxidation of mercury and of metals, 329
Bertrand, A., compound of titanium tetrachloride and acetyl chloride, 166
preparation of nitrous ethers, 73
solubility of lead phosphate and arseniate in dilute acetic acid, 165
Beryllium, atomic weight of, 251, 273
essential properties of, 297
Bevan, E. J., and C. F. Cross, chemistry of bast fibres, 77, 91
Bicalcic phosphate, properties of, 37
Bimmermann, E. H., F. Musculus, and J. Von Mering, transformations of starch and glycogen by diastase, 95
Bischoff, M., and T. Weyl, gluten, 109
Bismuth and bismuth compounds 242
Blondlot, R., new electric property of selenium, 329
Blood, recognition of human and animal, 307
Blue alizarin, 24
colour of the atmosphere, 305
Boake, Mr. Thomas Charles, death of, 197
Bödecker's method of detecting albumen in urine, 210
Bodies, certain non-metallic, dissociation of, 25
Bog butter, Irish, 47
Bone-glue, behaviour of on dry distillation, 175
Boric acid, complex acids containing, 282
in vinification, utility of, 259
Borntträger, H., rapid detection of aloes in elixirs, 306
Boro-deci-tungstic acid and its sodium salts, 210
Boron, place of in the series of simple bodies, 234
Bothamley, C. H., expelling and collecting gases in natural waters, 221
Böttger, R., behaviour of stannous chloride with potassium chlorate, 210
method for detecting albumen in urine, 210
Böttinger, C., phlobaphene, 96
Bottomley, J., absorption of light by turbid solutions, 218
colorimetry, 56
Bouchut, M., digestive ferment in the juice of the fig tree, 61
Bourgoin, E., bromoform, 83
electrolysis of malonic acid, 166
preparation of malonic acid, 13
Boussingault, J., rapid alcoholic fermentation, 197
saccharine matters contained in the fruit of the coffee tree, 258
Boys, C. V., and Prof. Guthrie, measurement of the conductivity of liquids by means of magneto-electric induction, 9
Braga, J. F., analyses of some hair-dyes, 8
Braham, P., analysis of a crystalline salt, 163
silver sulphate, 163
Braithwaite, W. and J., "Retrospect of Medicine" (review), 82
Brequet, A., photophonic experiments, 234
Bremer, G. J. W., splitting up of inactive malic acid, 109
British Association, 97, 111, 120, 123, 132, 157, 167
British Association, President's Address, 99
Bromated derivatives of nicotin, 23
Bromide and methyl iodide, action of upon mono-methyl-amin, 24
platinum, 120
potassium, colorimetric determination of chlorine in, 283
Bromine, action of upon diphenyl-methan, 72
and metallic bromides, detection of iodine in, 312
and sodium, volumes of at their boiling-points, 287
formation of carbon tetrabromide in the manufacture of, 288
in the analysis of sulphides, 259
Bromoform, 83
Brown, H. T., and J. Heron, hydrolytic ferments of the pancreas. 63
Mr., action at a distance, 268
Brugelmann, G., characteristics of the alkaline earths, 317
Brunner, Dr., determination of assimilable phosphoric acid, 305
Buisine, A., and E. Duvillier, action of ethyl chloride upon the ethyl-amines, 95
action of methyl-iodide and bromide upon mono methyl-amin, 24
Bunsen lamp, modification in the, 35
battery, improvement in by M. Azapis, 184
method for determining free oxygen in water, 206, 221
Burner, new gas heating, 187
Butter, estimation of, 306
fatty acids of, 72
Irish bog, 47
manufacture of factitious in the United States, 165
testing, 307

CAHOURS, A., and M. Etard, bromated derivative of nicotin, 23
Cairns, F. A., "Manual of Quantitative Chemical Analysis" (review), 82
Calomel, stability of, 78
Calorimetric determination of temperature, 120
Camphor, chlorides of, 210
peppermint, 268
Cane- and invert-sugar, specific rotatory power of, 177, 196, 208, 221, 233, 257, 269, 328
Cane-sugar, starch-sugar mixed with, 305, 326
Carbazol, 51
Carbo-hydrates, determination of in infants' food, 85
Carbon compound and the diamond, refraction equivalents of, 175
disulphide, heat formation of, 270
in steel, condition of, 131
varying condition of, 88
new synthesis of the acids of the, 96
oxide, determination of the fatal dose of for various animals, 317
tetrabromide in the manufacture of bromine, 288
Carbonic acid, behaviour of with Nessler's reagent and ammonia, 259
in the air, 13, 24, 35
atmosphere, fluctuations in, 83
Carbuncular disease, etiology of, 225
Carnelly, T., ice at high temperatures, 130
Caroba leaves, 61
Carpentin, M., fatty acids contained in oils, 211
Casamajor, P., detecting starch-sugar with cane-sugar, 305, 326
specific rotatory power of cane- and invert-sugar, 323
Caswell, C. B., electric versus gas lighting, 257
Caucasus, composition of the petroleum of the, 305
Caustic soda, vanadium in commercial, 185
Celluloid, 11, 59
Cerite and yttria, absorption-spectra of the metals forming part of the groups of, 193
Cerium in coal-measures, 253
Cervera, Dr., distinctions between human blood and that of other animals, 258
Chamberland, Roux, and L. Pasteur, MM., etiology of carbuncular disease, 225
Chappuis, J., and P. Hautefeuille, electric effluve, 132
liquefaction of ozone, 179, 294
ozone, 119
transformation of oxygen into ozone, 293
Chapuy, M., condensation of gases on the surface of glass, 49
Charpentier, A., sensibility of the eye to differences of light, 60
Chateau, T., oil of sheeps' feet, 166
Chaneau, A., nature of the immunity of Algerian sheep from splenic fever, 60
Chemical actions, thermic equilibrium of, 258, 259
affinity in terms of electromotive force, 302
measurement of, 249
changes in nitrogenous matter due to fermentation, 84
Committee of the Industrial Society of Mulhouse, 73
composition of ink on letters, &c., 32
constituents of Stereocaulon Vesuvianum, 271
constitution of milk, 271
laboratory at Griefswald, 96
mass of the elements, relations between, 47, 60
nomenclature, uniformity in, 80
processes, topography of in the animal system, 186
researches on the activity of bees, 84
on woody papilionaceous plants, 95
Section of the British Association, 111, 123
Society, 29, 90, 241, 267, 287, 313
American, 21, 44, 58, 207, 246, 291, 304
Newcastle, 277
Research Fund, 23, 29
Russian, 72, 234
"Chemical Analysis, Quantitative" (review), 82, 208
"Chimique Mécanique" (review), 53
Chemistry, history of the word, 68, 244
in the University of Virginia, 180, 193
of bast fibres, 77, 91
Schools of, 136, 156, 176
"Chemistry, Elements of" (review), 182
"Chemistry, Introduction to the Study of" (review), 33
Chemists, Society of Industrial, 234
"Chemists and Druggists, Directory of" (review), 45
Cheques, safety for: a new invention, 319
Chevreul, M., vision of colours, 60
Chevron, L., analysis of superphosphates, 329
Chicken cholera, 321
Chicory in ground coffee, determination of, 330
Chinolin, synthesis of, 211

Cholera, chicken, 321
Chloral, specific volume of, 288
Chlor-aluminium used at cloth works, 210
Chloride, methylene, preparation of, 7
rubidium-thallium, 175
stannous, peculiar reaction of with potassium chloride, 166
zinc, as a reagent for alkaloids, 318
Chlorides of camphor, 210
Chlorine, action of upon chromium sesquioxide, 24
and hydrochloric acid, action of upon lead chloride, 294
colorimetric determination of in potassium bromide, 283
preparation of, 132
solution of in water, 119
Chloro-chromic acid, salts of, 13
Chloroform, formation of, 294
Chlorophyll, modified, from the Eucalyptus globulus, 31
Chromium, estimation of in iron and steel, 285
sesquichloride, crystals of, of a persistent green colour, 209
sesquioxide, action of chlorine upon, 24
sulphur compounds of, 186
Chromometry, 48
Chromosphere, photography of the, 60
Church, J. A., heat of the Comstock lode, 42, 52
Ciamician, G. L., and H. Weidel, animal tar, 186
behaviour of bone-glue on dry distillation, 175
Cinnamic aldehyd in the digestion of fibrin, 109
Cinchomeronic acid, 186
Citric acid, synthesis of, 12
City technical science classes, 176
Clark, M., liquids and gases near their critical temperatures, 9
Clayton, E. G., Irish bog butter, 47
Clève, P. T., erbia, 199
thulium, 185
Cliff, D. G., action of a narrow slit on light, 12
Coal, determination of ash in, 41
measures, cerium in, 258
Coal-gas products, examination of soil for, 97
Coal-tar colours, identification of, 191
Cobalt and nickel, electrolytic determination of, 75
Cobalti-cyanide, certain compounds, 185
Coffee, ground, determination of chicory in, 330
saccharine matters contained in, 258
Coils of the Siemens type, improvements in, 60
Colleges and Universities, 133
Collodial oxide of iron, 23
Colophonium, distillation of, 209
Colorimetry, 56, 218
Colour-bases from furfurol, 24
Colour relations of nickel and cobalt, 56
Colours, coal-tar, identification of, 191
fixation of by silica, 49
vision of, 60
Colouring matters, analogous, 166
new, 109, 304
new class of from the phenols, 39, 44, 60
Colson, M. A., manufacture of phosphoric acid, 282
Combustion, heats of, 132
Comstock lode, heat of the, 42, 52
Copper and mercury, behaviour of sugars with alkaline solutions of, 96
presence of in sulphate of soda-crystals, 241
occurrence of, 259
Coralline, crystalline constituents of, 84
Corfield, W. H., "Laws of Health" (review) 207
Cotton-seed oil, detection of in admixture with olive, 27
Crafts, J. M., cause of variations in the fixed points of thermometers, 197
rise of the zero-point in mercurial thermometers, 165
thermometric questions, 222
variations of the coefficient of expansion of glass, 209
and C. Friedel, synthesis of hexamethyl-benzine, 132
Crompton, R. E., "Electric Light for Industrial Uses" (review), 232
Crookes, W., heat conduction in highly rarefied air, 309
remarks on the experiments of, 258
Cross, F. C., and E. J. Bevan, chemistry of bast fibres, 77, 91
C., mechanical actions of light, 234
Crucible, tubulated, for use in estimating volatile products of ignition, 326
Crystalline constituents of coralline, 84
lens, albuminoid matters of the, 12
Prussian blue, 210
salt, analysis of a, 163
salts, refrigerant mixtures formed of two, 13
Crystals of chromium sesquichloride of a persistent green colour, 209
polar electricity in hemihedral, 209
utilisation of chamber, 222
Cubic alum, 110
Curaçao guano, iodine in, 42
Curd, formation of, 96
Curie, P., and P. Desains, wavelengths of the thermic rays at low temperatures, 47
and M. Jacques, development of polar electricity in hemihedral crystals with inclined surfaces, 165
polar electricity in hemihedral crystals, 209
Cyanimide, 36
Cyanide, potassium, action of permanganate upon, 165
Cyanides, formation-heat of hydrocyanic acid and the, 83
Czubata, H., nutritive value of acorns, 95

DAMIEN, M., refraction indices of aqueous solutions of acetic acid and sodium hyposulphite, 184
Damoiseau, A., action of phosphorus upon hydriodic and hydrobromic acids, 329
D'Arcy, Power, and Harris, "Manual for the Physiological Laboratory" (review), 45
D'Arsonval, A., batteries, 132
Darwin, L., loss of light from phosphorescent substances, 302
Daturin, 109
Daubrée, M., meteorites which fell September 6, 1841, and November 26, 1874, 60
Davis, R. H., ancient alum well at Harrogate, 268
Davy, M. M., proportion of carbonic acid in the air, 13
De Coninck, M. O., pyridic bases, 146
De Forcrand, M., hydrated methyl iodide, 35
De Fraysseix, M., independent optical compass for ironclads, 48
Dehydrating agents, action of upon acids, 109
De la Source, L. M., colloidal oxide of iron, 23
Delbrück, M., chemical changes in nitrogenous matter due to fermentation, 84
Delesse, M., enrichment of plumbiferous earth, 294
Demarcay, E., researches on nitrogen sulphide, 317
De Marignac, C., review of Berthelot's "Mécanique chimique," 53
Dessains, P., and P. Curie, wavelengths of the thermic rays at low temperatures, 47
De Schulten, A., artificial reproduction of analcime, 35
Dennstedt, M., derivatives of para-brom-aniline, 97
Deutecom, B., determination of sulphur in iron pyrites, 317
Deutsch, A., and S. Gabriel, sulphuretted derivatives of diphenyl, 110
Dextrin and starch, detection of, 311
Dewar, J., critical-point of mixed vapours, 15
lowering of the freezing-point of water by pressure, 1
Diamond and carbon compounds, refraction equivalents of, 175
mine of South Africa, 85
Diazo-, amido-, and azo-compounds, 237
Diazo-colours with more than two sulpho-groups, 60, 72, 197
Diehl, W., volumetric determination of lead, 89
Diffraction, simple method of observing the phenomena of, 258
Dichromates, 109
Digallic acid, 36
Dimethyl-acrylic acid, new synthesis of, 210
Dimethyl, heat-formation of, 293
Dinitro-benzoic acid, 109
Dinitro-para-toluidine, 108
Dioxethylen-amines, methylated, 97
Diphenyl-methan, action of bromine upon, 72
Diphenyl, sulphuretted derivatives of, 110
Disinfection and preservation for agricultural purposes, 24
of animal matters, &c., 330
Disulpho-phenanthrenic acid, 109
Ditte, A., action of chlorine and hydrochloric acid upon lead chloride, 294
decomposition of salts by liquids, 222
fluorine compounds of uranium, 83
fluorised compounds of uranium with the alkaline metals, 95
refrigerant mixtures formed of two crystalline salts, 13
Dobbie, J. G., Graham Medal, 305
Donath, E., vanadium in commercial caustic soda, 185
Douglas, S. H., and A. H. Prescott, "Qualitative Chemical Analysis" (review), 208
Drechsler, A., detection of alcohol in ethereal oils, 318
Drewsen, V., determining the value of zinc-powder, 48
Drown, T. N., and P. W. Shimer, determination of silicon and titanium in pig-iron and steel, 299
T. M., determination of silicon in iron and steel, 331
Downes, A., simple process of slow actinometry, 178
"Druggists and Chemists, Directory of" (review), 45
Duboisine, 108
Duclaux, M., ferments of the albuminoid matters, 270
Ducretet, M., improvement in Bunsen's battery by M. Azapis, 184
Dufet, H., optical properties of mixtures of isomorphous salts, 165
Duvillier, E., and A. Buisine, action of ethyl chloride upon ethyl-amines, 95
Dumas, M., gases retained by occlusion in aluminium and magnesium, 318
Du Roi, P., experiment with Feser's lactoscope, 95
Duvillier, E., and A. Buisin, action of methyl-iodide and bromide upon mono-methyl-amine, 24
new synthesis of dimethyl-acrylic acid, 210
Dwight, G. S., Strong's water-gas system, 27
Dyes, infusorial earth with, 175
Dynamite, industrial preparation of, 165

EARTH, &c., induction of the moon by the, 209
Earths and their sulphates, molecular heats and volumes of the rare, 119
Eggertz, Prof., phosphorus estimation in iron and iron ores, 87
Ekunina, M., cause of the acid reaction of animal tissues after death, 164
Electric current, result of irritation of the liver by, 186
effluve, 132
lights, 291
lighting, 227, 257
recent history of, 310
motor, new, 330
property of selenium, new, 329
"Electric Light for Industrial Uses" (review), 232
Electrical resistance, 70
Electricity, atmospheric, 95
observed in the north of the Sahara, 210
in the service of life, 73
polar, in hemihedral crystals, 209
Electro-dynamic paradox, 119
Electrolysis, action of upon benzol, 95
contribution to, 331
Electrolytic determination of nickel and cobalt, 75
Electro-magnetic machines, I w of, 221
Electromotive force, chemical affinity in terms of, 302
Electromotor force of the electric arc, 95
Elements, relation between the atomic volumes of certain, 171
Elixirs, rapid detection of aloes in, 306
Elliot, A. H., American Chemical Society, 21
Emmerling, A., albumen in plants, 96
Endemann, H., and G. A. Prochazka, laboratory notes, 8
constitution of ultramarine, 204, 291
Equations, negative bonds, and rule for balancing, 51
Erbia, 199
Erbium and ytterbium, spectra of, 184
Erlenmeyer, E., phenyl-lactic acids, 109
Etard, M., and A. Cahours, bromated derivative of nicotin, 23
magnetic apparatus of, 258
place of boron in the series of simple bodies, 234
Ether, acetic, continuous method of preparing, 72
preparation of neutral sulphuric, 13
Ethers, 210
heat of formation of, 270
preparation of nitrous, 73
Ethereal oils, detection of alcohol in, 318
Etherification of phenols, 164
Ethyl-chloride, action of upon the ethyl-amines, 95
Ethylen-iodo-picrate, 108

Etiology of carbuncular disease, 225
rinder-pest, 83
Eucalyptus globulus, modified chlorophyll from, 31
Eupittonic acid as a volumetric indicator, 36
Eutropy, specific heats calculated from, 9
Examinations, London University, 133
Science and Art Department, 135, 166
"Explosives Committee Report" (review), 232
Eye, sensibility of to differences of light, 60

FALLOWS, action of, 95
Fats, formation of in the lower fungi, 185
saponification of, 317
Fatty acids contained in oils, 211
matters, purification and refining of, 166
series, combustion-heats of certain bodies of the, 132
Fautrat, M., influence of forests upon rain-fall 95
Fecula, determination of in potatoes, 175
Ferriferous and aluminiferous superphosphates, reversion of, 90
Feser's lactoscope, 95
Field Club, Newcastle Students', 223
Fig tree, digestive ferment in the juice of, 61
Fibrin, cinnamic aldehyd in the digestion of, 109
Filter-pump, new form of, 286
Fire- and water-proof paper, 330
Fischer, E., disulpho-phenanthrenic acid, 109
new colouring-matter, 109
Fittbogen, J., and P. Hasselbaith, fluctuations in the proportion of carbonic acid in the atmosphere, 83
Flames, certain properties of, 184
Fliche, P., and L. Grandeau, chemical researches on woody papilionaceous plants, 95
Fleck, H., detection of picric acid in beer, 259
Fletcher, T., heating by gas, 238
"Floral" manure, 330
Fluorine compounds of uranium, 83
of vanadium, 85
Fog question, 327
Food, adulteration of, 271
Foods, infants', determination of carbohydrates in, 85
Forage biscuits, analysis of, 287
Forests and fields, meteorological observations in, 83
Forguignon, M. L., malleable cast-iron, 295
Formic acid, synthesis of, 109
Francaise rouge, 108
Frankland, E., and D. A. Louis, action of zinc-ethyl on benzoylic cyanide, 242
Fraser, A. T., new hydrogen compounds, 220
Fresenius, H., and F. Bergmann, electrolytic determination of nickel and cobalt, 75
of silver, 76
Friedel, C., and J. M. Crafts, synthesis of hexamethyl-benzine, 132
and M. Balsohn, action of bromine upon diphenyl-methan, 72
of mono-bromated diphenyl-methan upon ammonia, 283
Fruits of different ages, behaviour of juices of with reagents, 48
tin in preserved, 34, 47
Funaro, A., formation of the fatty matter of the olive, 247
Fungi, formation of fats in the lower, 185
Furfurol, colour bases from, 24
colouring bases derived from, 247
Furnace smoke, disposal of, 85

GABRIEL, S., and A. Deutsch, sulphuretted derivatives of diphenyl, 110
Galena produced at the Lyon Glass Works, 49
Galvanometer, new form, 48
Garnier, J., process for producing malleable nickel of different degrees of hardness, 185
Gas analysis, 306
companies and tar distillers, 12
heating burner, new, 187
heating by, 238
presence of sulphur in illuminating, 303
Gaseous mixtures, inflammation temperatures of, 295
Gases and liquids near their critical temperatures, 9
compressibility of under strong pressure, 209
condensation of on the surface of glass, 49
retained by occlusion in aluminium and magnesium, 318
rotatory magnetic polarisation in, 24
Gastynski, L., new form of galvanometer, 48
Gehe and Co., Dresden, "Trade Report" (review), 208
Geological Section of British Association, 167
Gerber, R., chemical constitution of milk, 271
Germain, P., application of selenium for baking stained glass, 270
German Association of Naturalists, 292
Genther, A., new synthesis of the acids of carbon, 96
Giacosa, P., salireton, 36
Gilbert, J. H., address, 111, 123
Gintl, W., crystalline Prussian blue, 210
Girard, C., and A. Pabst, utilisation of chamber crystals, 222
Giraud, E., preparation of indoline and its compound, 24
Gladstone, Dr. J. H., and A. Tribe, aluminium alcohols, 267
aluminium-iodine reaction, 2
refraction equivalents of isomeric bodies, 9
of the diamond and carbon compounds, 175
Glasgow Philosophical Society, 281, 314
Glass, application of selenium for baking stained, 270
condensation of gases on the surface of, 49
modifications undergone by, 270
variations of the coefficient of expansion of, 209
wool in filtration, 318
Glucinum, atomic weight of, 95
Gluconic acid, 186
Glucosides of a complicated structure, formation of, 259
Gluten, 109
Glycerin in beer, 36
quantitative determination of, 175
Glycogen and starch, transformation of by diastase, 95
Glykosamine, 247
Gold and silver, cupelling of, 27
determination of in alloys, 331
Goldschmiedt, G., idryl, 210
Gonnard, F., galena produced at the Lyon Glass Works, 49
Gooch, F. A., tubulated crucible for estimating volatile ignition, 326
Gouy, M., measure of the intensity of certain dark rays of the solar spectrum, 200
photometric apparatus, 318
propagation of light, 329
Govi, G., direction of rotation impressed by substances upon polarised light, 222
Graebe, C., alizarin blue, 24
carbazol, 51
and W. Knecht, phenyl-naphthyl-carbazol, 61
Graham medal, 223, 305
W. C., and H. E. Armstrong, some derivatives of naphthalene, 243
Grain, commercial, value of, 35
Gramme machine, study on, 330
Grandeau, L., and P. Fliche, chemical researches on woody papilionaceous plants, 95
Grape-sugar, wines mixed with, 318
Gravi-volumetric method, analyses of pyrites by the, 20
Gray, M., specific heats calculated from eutropy, 9
Greene, W. H., aceto-benzoic anhydride, 166
preparation of methylene chloride, 7
Gréhaut, M., fatal dose of carbon oxide for various animals, 317
Greifswald, chemical laboratory at, 96
Griess, P., ammonium compounds, 108
Griessmayer, V., determination of glycerin in beer, 36
Grimeaux, E., and P. Adam, synthesis of citric acid, 12
Grimshaw, H., presence of sulphur in illuminating gas, 303
Groeger, M., sulphur compounds of chromium, 186
Grothe, Dr., weighing textile fabrics, 97
Guanidin, 25
Guano-iodine in Curaçao, 42
Guanos, Australian, 329
Guaresci, J., podophyllin, 36
Guber, N., determination of carbohydrates in infants' foods, 85
Guignet, C. E., proximate analysis of peat, 329
Gun-cotton, formation-heat of, 282
Guthrie, Prof., and C. V. Boys, measurement of the conductivity of liquids, 9

HAAS, R., testing petroleum for its inflammability, 85
Hadelich, W., occurrence of copper, 259
Hæmine, crystals of, 211
Hager, H., detection of arsenic in non-metallic liquids, 331
specific gravity of solid fats, 307
tests of bees'-wax, 181
Hair dyes, analyses of some, 8
Halle, University Laboratory of, 13, 96
Haloid salts, oxidation of, 120
Hamilton, J. C., formation of carbon tetra-bromide in the manufacture of bromine, 288
Hargreaves, J., manufacture of sulphate of soda, 322
Harris, V., and D'Arcy Power, "Manual for the Physiological Laboratory" (review), 45
Harrogate, ancient alum well at, 268
Hartley, W. N., absorption-spectrum of ozone, 268
blue colour of the atmosphere, 305
Hasselbaith, P., and J. Fittbogen, fluctuations of the proportion of carbonic acid in the atmosphere, 83
Hautefeuille, P., and J. Chappuis, electric effluve, 132
liquefaction of ozone, 179, 294
ozone, 119
transformation of oxygen into ozone, 293
"Health, Laws of" (review), 207
Heat-conduction in highly rarefied air, 309
Heat, utilisation of solar, 209
Heating by gas 238
Heiden, E., manurial experiments on rye, 95
Hemihedral crystals with inclined surfaces, development of polar electricity in, 165
Heron, J., and H. T. Brown, hydrolytic ferments of the pancreas, 63
Herzfeld, A., malto-dextrin, 96
Herzen, A., utility of boric acid in vinification, 259
Hesse, O., caroba leaves, 61
pereiro bark, 61
Heumann, K., certain ultramarine compounds, 24
Hexamethyl benzine, synthesis of, 132
Hoffmeister, G. B., bismuth and bismuth compounds, 242
Hofmann's eupittonic acid as a volumetric indicator, 36
Hogg, T. W., condition of carbon in steel, 131
Hoglan, P., stability of calomel, 178
Högyes, F., crystals of hæmine, 211
Hollway process in Queensland, 187
Holman, Mr., cupelling of gold and silver, 27
Honey sophisticated with starch-sugar, 271
Hönig, M., gluconic acid, 186
Houze, A., manufacture of sulphuric acid, 85
technical extraction of phosphoric acid from mineral phosphates, 85
Houzeau, M. A., analyses of pyrites by the gravi-volumetric method, 20
Hughes, J., analysis of shoddy and wool waste, 325
Human blood and that of other animals, distinctions between, 258
Humpidge, T. S., atomic weight of beryllium, 261
Hydracids, etherification of the, 61
Hydrated methyl iodide, 35
Hydriodic and hydrobromic acids, action of phosphorus upon, 329
Hydriodic and hydrochloric acids, etherification of, 48
Hydrobromic acid, etherification of, 35
and hydriodic acids, action of phosphorus upon, 329
Hydrocarbons, heat of combustion of the principal, 12
Hydrochloric acid and chlorine, action of upon lead chloride, 294
and hydriodic acids, etherification of, 48
Hydrocyanic acid and the cyanides, formation-heat of, 83
so-called spontaneous decomposition of, 73
Hydrofluosilicic acid, crystalline, 13
Hydrogen and sodium hyposulphite, reaction between, 185
compound, new? 220
peroxide and ozone, 17, 34
Hydrolytic ferments of the pancreas, 63
Hydroscyamine, 108
Hydroxide, aluminium, new isomeric modification of, 119
Hypochlorine, 210
Hyponitric anhydride, action of upon organic bodies, 304

ICE at high temperatures, 130
Idryl, 210
Images, application of accidental, 330
Indigo, artificial, 7, 267
"Indigo," use of the term of by Newton, 37
history of the artificial preparation of, 289

Indium in Norwegian minerals, 85
Indoline and its compounds, preparation of, 24
Infusorial earth with dyes, 175
Ink on letters, &c., chemical composition of, 32
Institution of Great Britain, Royal, 235, 319
Iodide, hydrated methyl, 35
Iodides, action of light upon soluble, 147
Iodine, density of the vapour of, 60, 82
detection of in bromine and metallic bromides, 312
from sea-weeds, preparation of ashes for extracting, 282
in Curaçao guano, 42
Irish bog butter, 47
Iron, aluminium sulphate free from, 191, 202
and iron ores, estimation of phosphorus in, 87
and steel, determination of silicon in, 331
estimation of chromium in, 285
colloidal oxide of, 23
malleable cast, 295
preventing from rusting, 271, 286
pyrites, determination of sulphur in, 317
Isambert, M., combinations of ammoniacal gas with palladium chloride and iodide, 294
Ishikawa, J., materials containing tannin used in Japan, 274
Isomeric bodies, refraction equivalents of, 9
Isomerism, 294
Isomorphism, certain cases of, 84
Isomorphous salts and fractional crystallisation, 304
optical properties of, 165

JACQUES, M., and P. Curie, development of polar electricity in hemihedral crystals with inclined surfaces, 165
polar electricity in hemihedral crystals, 209
Jahn, H., decomposition of simple organic compounds by zinc-dust, 210
Jamin, J., effects of the reversal of photographic images by the prolongation of luminous action, 35
Janssen, J., transformations of the photographic image by the prolongation of the luminous action, 119
photography of the chromosphere, 60
Japan, materials containing tannin used in, 274
Johnson, O. C., negative bonds, and rule for balancing equations, 57
W. H., electrical resistance, 70
Jorissen, A., detection of iodine in bromine and metallic bromides, 312
zinc chloride as a reagent for alkaloids, &c., 318
Joubert, J., electromotor force of the electric arc, 95
law of electro-magnetic machines, 221
Joulie, H., H. Albert, and Dr. Vollbrecht, reversion of phosphates and the behaviour of phosphoric acid in the soil, 35
Jüptner, M., detection of mercury, 186
Jurisch, K., technical analysis and valuation of Mond's sulphur lyes, 97
testing Weldon mud, 97

KAY, W. E., sulphides of vanadium, 242
Kayser, H., phosphoric acid in wine, 85
the ash in wines, 49
Kellermann, C., and E. Ranmer, function of lime in the life of plants, 211
"Kelly's Directory of Chemists and Druggists" (review), 45
Kern, S., Siemens-Martin steel, 287
Kerner, G., volumetric determination of quinine sulphate, 318
Kessler, M., crystalline hydrofluosilicic acid, 13
Kingzett, C. T., hydrogen peroxide and ozone, 34
reply to Dr. Leeds, 164
Klein, D., boro-decl-tungstic acid and its sodium salts, 210, 221
injurious effects of water from peat moors and alder swamps upon meadows, 84
tungsto-boric acid, 209
Knecht, W., and C. Graebe, phenyl-naphthyl carbazol, 61
Kochs, W., topography of chemical processes in the animal system, 186
Kœnig, G. A., chromometry, 48
J., and C. Krauch, Bunsen's method for determining free oxygen in water, 206
determination of the free oxygen dissolved in water, 218
Kolbe, H., action of woody fibre upon salicylic acid, 120
destructive action of woody fibre upon salicylic acid, 223
Koller, T., "Utilisation Recovery, &c., of Residual Matters" (review), 33
Könige, E., examination of soil for coal-gas products, 97
W., action of phosphorus perchloride and oxychloride upon cinchonin hydrochlorate, 106
Krauch, C., and J. Kœnig, Bunsen's method for determining free oxygen in water, 206
determination of the free oxygen dissolved in water, 218
Kraus, F., determination of gold and silver in alloys, 331
Kurbatow, A., and F. Beilstein, dinitro-benzoic acid, 109
Kynaston, J. W., aluminium sulphate free from iron, 191, 202

LAARBACH, L., action of phenol upon halogen-substituted fatty acids, 36
Laboratory notes, 8
La Costa, W., and A. Michaelis, aromatic arsenical compounds, 20
Lactoscope, Feser's, 95
Ladenburg, A., and L. Rügheimer, artificial formation of tropic acid, 110
tropidine, 108
Lava, Vesuvius, of 1631, yellow incrustations of the, 37
Lead, action of concentrated sulphuric acid on, 314
and its salts with regard to health, 247
desilverisation of by the zinc process, 281
Norwegium in American, 76
phosphate and arseniate, solubility of in dilute acetic acid, 165
volumetric determination of, 89
Leather, mineral, 121
Lechat, F., vibrations of the surface of liquids, 48
Le Chatellier, M., and M. Mallard, inflammation temperatures of gaseous mixtures, 295
Lecture experiment, 118
Ledderhose, G., glykosamine, 247
Leeds, A. R., action of light and darkness on standard tannin solutions, 44
upon soluble iodides, 147
formation of hydrogen peroxide and ozone, 17
new methods in actino-chemistry, 44
production of ozone, 304
Leeds's criticism, reply to Dr., 155, 164
Leffmann, H. A., lecture experiment, 118
Lehne, A., condensation of benzhydrol and naphthaline, 109
Lescuyer, M. G., electro-dynamic paradox, 119
Levallois, A., and S. Meunier, crystalline anhydrous lime, 48
Lévy, A., ammonia in the air and the waters, 83
Libraries, technical museums and, 307
Life, electricity in the service of, 73
Light, absorption of by turbid solutions, 218
action of a narrow slit on, 12
upon soluble iodides, 147
and darkness, action of on standard tannin solutions, 44
direction of rotation impressed upon substances by, 222
distribution of in the solar spectrum, 234
in the spectrum, 9
formulæ for the intensity of, 56
mechanical actions of, 234
propagation of, 329
sensibility of the eye to differences of, 60
Lighting, electric, 227, 257
recent history of, 310
Lightning ascending vertically, 209
Lights, electric, 291
Lime, process for treating mineral and other substances containing phosphate of, 177
Lindo, D., red oxide of mercury in old samples of grey powder, 67
Lintner, H., beer analysis, 175
Liquids, agitation of, 13
and gases near their critical temperatures, 9
measurement of the conductivity of, 9
petroleum spirit and allied, 189
vibrations on the surface of, 48
Literary and Philosophical Society, Newcastle, 227
Lithium glass, 36
Liversidge, A., water from a hot spring, Fiji Islands, 324
New Britain, 324
Loewe, J., analysis of soaps, 53
Loew, O., and E. Nägeli, formation of fats in the lower fungi, 185
synthesis of formic acid, 109
Lomas, J., "Manual of the Alkali Trade" (review), 22
London School of Pharmacy, South, 307
University examinations, 133
Longuinine, W., combustion-heats of certain bodies of the fatty series, 132
œnanthol, 13
Lossen, F., guanidin, 25
Louis, D. A., and E. Frankland, action of zinc ethyl on benzoylic cyanide, 242
Luff, A. P., "Introduction to the Study of Chemistry" (review), 33
Lunge, G., "Manufacture of Sulphuric Acid and Alkali" (review), 21
Weldon mud, 19
Lux, F., volumetric determination of red lead, 306

MACAGNO, I., tannin in wines, 84
Macé, J., and W. Ricati, distribution of light in the spectrum, 9, 234
Mach, E., C. Portele, and C. Von Baba, tartar and tartaric acid in must and wine, 84
Machines, electro-magnetic, law of, 221
Magerstein, J. T., value of nitrogenous manures in the development of plants, 185
Magnesia on vegetation, effects of, 213
Magnesium and aluminium, gases retained by occlusion in, 318
vanadiates, 85
Magnetic apparatus of M. Etard, 258
bodies, telephonic effects from the shock of, 83
nucleus submitted to an electric current, mechanical effects produced in, 48
polarisation of gases, rotatory, 24
super-excitation, telephone with, 12
Malic acid, inactive, splitting up of, 109
Mallard, M., and M. Le Chatellier, inflammation temperatures of gaseous mixtures, 295
Malleable cast-iron, 295
Mallet, J. W., chemistry in the University of Virginia, 180, 193
Malonic acid, electrolysis of, 166
preparation of, 13
Malto-dextrine, 96
Manganese hydrate, some causes of variation in the precipitation of by ammonia, 259
Manchester Literary and Philosophical Society, 31, 56, 68, 218, 244, 289, 303
"Manchester, Science Lectures delivered in" (review), 46
Manganese ore, antimoniferous, 223
Manganese, oxides of, 267
Manure, alkali waste as a, 295
"floral," 330
"separation-mud" as, 84
Manures, nitrogenous, value of in the development of plants, 185
Marchaud, F., metha-emoglobine 185
Märcker, M., A. Morgen, and P. Behrend, determination of fecula in potatoes, 175
Marguerite, P., new aluminium sulphate, 23
Mascart, M., atmospheric electricity, 95
Masino, F., derivatives of myristic acid, 84
Masson, D. O., and W. Ramsay, volumes of bromine and sodium at their boiling-points, 287
Mathematical and Physical Section of British Association, 157
Matthieu, A., meteorological observations in fields and forests, 83
Maumené, M., sophistication of oils, 175
Mauri, F., complex acids containing boric acid, 282
Mayencon, M., cerium in coal-measures, 258
Mayer, L., quantitative determination of arsenious acid in the presence of arsenic acid, 222
Meadows, injurious effect of water from peat moors and alder swamps upon, 84
Meat, butcher's, peculiar alteration in, 95
"Mécanique Chemique" (review), 53
Meconic acid, some double salts of, 75
Medicine, rarefied, discharge in a, 183
"Medicine, Retrospect of" (review), 82
Medicus, L., and S. Scherer, estimation of butter, 306
Mehu, C., determination of urea by sodium hypobromite, 166
Meldola, R., diazo-colours with more than two sulpho-groups, 60, 72
new class of colouring-matters from the phenols, 39, 60

Meldola, R., nitroso-naphtho sulphonic acid, 175
Melikoff, P., oxyacrylic acid, 108
Mengeot, A., crystals of chromium sesquichloride of a persistent green colour, 209
Menozzi, C., and G. Musso, albumen of milk and the formation of curd, 96
Mercurial thermometers, rise of zero-point in, 165
Mercury, detection of, 186, 307
red oxide of in old samples of grey powder, 67
spontaneous oxidation of, and of metals, 329
Metallic bromides and bromine, detection of iodine in, 312
Metallurgical treatment of complex ores containing zinc, 201
Metals, action of oils on, 190
alkaline, vapour densities of the, 110
and mercury, spontaneous oxidation of, 329
Meteoric mineral, new, 35
Meteorites which fell Sept. 6th, 1841, and Nov. 26th, 1874, 60
Meteorological observations in fields and forests, 83
Methyl iodide and bromide upon mono-methylamine, action of, 24
Methyl iodide, hydrated, 35
Methylated dioxethylen-amines, 97
Methylene, chloride preparation of, 7
Metropolitan waters, composition and quality of, 211, 319
Meunier, S., and A. Levallois, crystalline anhydrous lime, 48
Meyer, A., adulterations of saffron, 259
C. F., reversion of ferriferous and aluminiferous superphosphates, 90
reverted phosphoric acid, 118
V., calorimetric determination of temperature, 120
vapour-densities of the alkaline metals, 110
and H. Güblin, platinum bromide, 120
Meyreneuf, M., certain properties of flames, 184
Michaelis, A., and W. La Costa, aromatic arsenical compounds, 20
Microscopical examination of water, 85
Milk, albumen of, 96
chemical constitution of, 271
condensed, 96
Miller, M., new air-thermometer, 258
Miller, W. A., "Elements of Chemistry" (review), 182
Millot, A., properties of bicalcic phosphate, 37
Mineral leather, 121
Mineral, new meteoric, 35
oils, heavy, detection and determination of, 39
water, Trefriw, 176
Mines, Royal School of, introductory lecture at the, 254, 263
Mining Atlas, Pocket" (review), 47
Miquel, P., atmospheric bacteria, 61
Mohr, C., volumetric determination of phosphoric acid, 306
Moissan, H., action of chlorine upon chromium sesquioxide, 24
Molybdic acichlorides, 13
Mond's sulphur lyes, technical analysis and valuation of, 97
Mono-bromated diphenyl-methan upon ammonia, action of, 283
Mono - naphthylamines from naphthols, 302
Moon by the earth, induction of, 209
Morgen, A., P. Behrend, and M. Märcker, determination of fecula in potatoes, 175
Moride, E., "nutricine," 293
Moriza, M., peppermint camphor, 268
Morley, H. F., methylated dioxethylen amines, 97
Morton, Prof. H., electric lights, 291
recent history of electric lighting, 310
Motor, new electric, 330
Muck, F., determination of ash in coal, 41
removal of large quantities of sodium and potassium chloride in mineral analyses, 305
Mud, Weldon, 10, 19, 97, 246
Muir, M. P., bismuth and bismuth compounds, 242
Mulhouse, Industrial Society of, 165
chemical committee of the, 73
Musculus, F., J. Von Mering, and E. H. Bimmermann, transformations of starch and glycogen by diastase, 95
Museums and libraries, technical, 307
Musso, G., and C. Menozzi, albumen of milk and the formation of curd, 96
Mylius, E., zinc in spring waters, 49
Myristic acid, derivatives of, 84

NAGELI, C., and O. Loew, formation of fats in the lower fungi, 185
Naphthalene, some derivatives of, 243
Naphthaline and benzhydrol, condensation of, 109
Naphthols, mono - naphthylamines, 302
Naphthyl-carbazol, phenyl, 61
Naphthylamines, mono-, from naphthols, 302
Napier, J., jun., action of concentrated sulphuric acid on lead, 314
National Academy of Sciences, New York, 291
Naturalists, German Association of, 292
"Nature, Spirit of" (review), 46
Nessler, J., and H. Wachter, free tartaric acid in wine, 95
Newcastle Chemical Society, 277
Literary and Philosophical Society, 227
Students' Field Club, 223
Nicati, W., and J. Macé, distribution of light in the spectrum, 9, 234
Nickel and cobalt, colour relations of, 56
electrolytic determination of, 75
in Cornish manganese, 241
of different degrees of hardness, process for producing, 185
Nickels, B., detection of cotton-seed oil in admixture with olive, 27
Nicotin, bromated derivative of, 23
Nilson, L. F., and O. Pettersson, atomic weight of glucinum, 95
essential properties and chemical character of beryllium, 297
molecular heats and volumes of the rare earths and their sulphates, 119
atomic weight of scandium, 83
ytterbium, 61
"Nitre, The Nature of," 283
Nitrogen, determination of, 49
estimation of by combustion, 313
sulphide, researches on, 317
Nitrogenous matter, chemical changes in due to fermentation, 84
Nitro-ortho- and nitro-para-azophenetols, 96
Nitroso-naphthol-sulphonic acid 1
Nitrous ethers, preparation of, 73
vapours, constitution of so-called, 185
Non-metallic bodies, dissociation of certain, 25
Norwegium in American lead, 76
Norwegian minerals, sodium in, 85
"Nutricine," 293

OBITUARY, 197
Œnanthol, 13
Ogier and Berthelot, MM., isomerism, 294
Oil of sheeps' feet, 166
Oils, action of on metals, 190
fatty acids contained in, 211
heavy mineral, detection and determination of, 39
sophistication of, 175
Olive, detection of cotton-seed oil in admixture with, 27
formation of the fatty matter of the, 247
Optical and visual phenomena, certain, 329
compass for ironclads, independent, 48
properties of mixtures of isomorp ous salts, 165
Organic alkalies, researches on, 95
bodies, melting-point of, 36
compounds, combustion-heats of, 222
decomposition of simple by zinc-dust, 210
Ossikrovsky, J., cinnamic aldehyd in the digestion of fibrin, 109
Oxidation of haloid salts, 120
spontaneous, of mercury and of metals, 329
Oxide, carbon, fatal dose of for various animals, 317
of iron, colloidal, 23
silver, action of cane-sugar on, 260
zinc, in alkaline solutions, 30
Oxides of manganese, 267
nitrogen and those of sulphur, formation-heat of, 35
Oxyacrylic acid, 108
Oxygen, compressibility of, 294
determining free in water, 206, 218, 221
transformation of, 293
Ozone, 119, 176
absorption-spectrum of, 268
and hydrogen peroxide, formation of, 17
hydrogen peroxide and, 34
in the evaporation of different liquids, 175
liquefaction of, 179, 294
production of, 304
transformation of oxygen into, 293

PABST, A., and C. Girard, utilisation of chamber crystals, 222
J. A., continuous method of preparing acetic ether, 72
Palisander wood, resin of, 166
Palladium chloride and iodide, combinations of ammoniacal gas with, 294
Pancreas, hydrolytic ferments of the, 63
Papaine, 24, 294
Paper, fire- and water-proof, 330
Papilionaceous plants, woody, chemical researches on, 95
Para-brom-aniline, 97
Paradox, electro-dynamic, 119
Paris, odours of, 221
Parker, J. S., varying condition of carbon in steel, 88
Parkes, A., celluloid, 59
Parnell, E. A., metallurgic treatment of complex ores containing zinc, 201
Passavant, L. M., specific volume of chloral, 288
Pasteur, L., chicken cholera, 321
M. Chamberland, and M. Roux, etiology of carbuncular disease, 225
virulent diseases, 4
Patent Bill, the new, 11, 34
Paterno, E., chemical constitution of stereocaulon vesuvianum, 271
Pawlewski, B., speed of reactions, 109
Peat, proximate analysis of, 329
Peligot, E., saccharine, 318
Pellat, M., theory of the battery, 258
Pellegrini, M., physico-chemical analyses of soils, 210
Pellet, H., fixity of the composition of plants, 24
Pelleux, M., study on the Gramme machine, 330
Peppermint camphor, 268
Pereiro bark, 61
Permanganate, action of upon potassium cyanide, 165
Perkin, W. H., artificial production of indigo, 267
Peroxide, hydrogen, and ozone, 34
formation of, 17
Persoz, J., analysis of mixed tissues of silk and cotton, wool and cotton, &c, 73
Perutz, H., removal of last traces of sulphuric acid after refining petroleum, 186
Petrcleum of the Caucasus, composition of, 305
products contained in the coke of, 282
removal of last traces of sulphuric acid after refining, 186
spirit and allied liquids, 189
testing for its inflammability, 85
Pettersson, O., and L. F. Nilson, atomic weight of glucinum, 95
essential properties and chemical character of beryllium, 297
molecular heats and volumes of the rare earths and their sulphates, 119
Pfluger, E., determination of urea, 186
Pharmacy, South London School of, 307
Phenols, action of upon halogen-substituted fatty acids, 36
etherification of, 164
new class of colouring matters from the, 39, 44, 60
Phenyl-lactic acids, 109
Phenyl-naphthyl-carbazol, 61
Phillips, S. E., constitution of amido-, azo-, and diazo-compounds, 237
Philosophical and Literary Society of Manchester, 31, 56, 68, 218, 244, 289, 303
Newcastle, 227
Society of Glasgow, 281, 314
"Philosophical Society, Washington" (review), 182
Phipson, Dr. T. L., presence of copper in sulphate of soda crystals, 241
nickel in Cornish manganese, 241
rusting of iron, 286
Phlobaphene, 96
Phosphate, sodium, use of in dyeing, 330
value of precipitated and reverted, 259
Phosphoric acid, assimilable, determination of, 305
behaviour of in the soil, 35
in wine, 5
manufacture of, 282
reverted, 118
technical extraction from mineral phosphates, 85
volumetric determination of, 306
Phosphorescent substances, loss of light from, 302
Phosphorus, action of upon hydriodic and hydrobromic acids, 329

Phosphorus, estimation in iron and iron ores, 87
in urine in a case of acute poisoning, 259
perchloride and oxychloride, action of upon cinchonine hydrochlorate, 106
Photo-chemistry of silver, 186
Photographic image, transformations of by the prolongation of the luminous action, 119
images, effects of the reversal of by the prolongation of lumination, 35
Photography of the chromosphere, 66
Photometric apparatus, 318
Photophonic experiments, 234
Photophone, application of to the study of the sun, 270
Phthalic acid, compounds of with the phenols, 61
Physical and Mathematical Section of the British Association, 157
Society, 9, 268, 277, 302
Physico-chemical analyses of soils, 210, 247
"Physiological Laboratory, Manual for the" (review), 45
Phytolaccic acid, 317
Pictet, R., dissociation of certain non-metallic bodies, 25
Pickering, S., oxides of manganese, 267
S. U., detection of starch and dextrine, 311
Picric acid in beer, detection of, 259
Pifre, M. A., utilisation of solar heat, 209
Pig-iron and steel, determination of silicon and titanium in, 299
Pitkin, L., isomorphous salts and fractional crystallisation, 304
Planta, A., detection of honey sophisticated with starch-sugar, 271
Plants, albumen in, 96
fixity of the composition of, 24
function of lime in the life of, 211
Plateau, J., application of accidental images, 330
Platinum bromide, 120
solution of in sulphuric acid, 61
sulphocyanide, 166
Plumbiferous earth, enrichment of, 294
Podophyllin, 36
Poincaré, M., peculiar alteration in butchers' meat, 95
Poisoning, acute, detection of phosphorus in urine in a case of, 259
Polar electricity in hemihedral crystals, 209
Polis, A., cubic alum, 110
Polysulphides, alkaline, thermic study of the, 48
ammonium, thermic researches on the, 60
Pork, American, insalubrity of, 318
Portele, C., C. v. Babo, and E. Mach, tartar and tartaric acid in must and wine, 84
Post, J., reply to Mr. Weldon, 233
Potassium and sodium, aluminates of in solution, 29
chlorate, behaviour of stannous chloride with, 210
peculiar reaction of stannous chloride with, 168
cyanide, action of permanganate upon, 165
Potatoes, determination of fecula in, 175
Pothier, E., transformation of war powder in the metal cartridge boxes of the infantry, 23
Prætorius, G., salts of chlorochromic acid, 13
Prescott, A. B., aluminates of potassium and sodium in solution, 29
Presscott, A. H., and S. Douglas, "Qualitative Chemical Analysis" (review), 208
Pringsheim, M., hypochlorine, 210
Prochazka, G. A., aad H. Endemann, laboratory notes, 8
Norwegium in American lead, 76
Protein bodies, 108
Prunier, L., and E. Varenne, products contained in the coke of petroleum, 282
determination of chicory in ground coffee, 330
Prussian blue, crystalline, 210
Puliti, G., some causes which hinder or facilitate the precipitation of manganese hydrate sy ammonia, 259
Pump, filter, new form of, 286
Puttback, W., molybdic acichlorides, 13
Pyridic bases, 146
Pyrites, analyses of by the gravimetric method, 20
determination of sulphur in, 317

QUAJAT, P., combustibility of certain kind of tobacco, 96
"Qualitative Chemical Analysis" (review), 208
"Quantitative Chemical Analysis" (review), 82
Queensland, Hollway process in, 187
Quesneville, G., determination of specific heats at a constant volume in simple and compound bodies, 72
Quet, M., induction of the moon by the earth, &c., 209
Quinine sulphate, volumetric determination of, 318

RAINFALL, influence of forests upon, 95
Ramsay, A. C., inaugural address to the British Association, 99
Rarefied medium, discharge in a, 183
Raumer, E., and C. Kellermann, function of lime in the life of plants, 211
Reactions, speed of, 109
Red-lead, volumetric determination of, 306
Red oxide of mercury in old samples of grey powder, 67
Reichardt, E., use of bromine in the analysis of sulphides, 259
Reimann, Dr., infusorial earth with dyes, 175
Reinsch, H., antimoniferous manganese ore, 223
Reiset J., proportion of carbonic acid in the air, 35
Rémont, M. A., detection and determination of heavy mineral oils, &c., 39
Rénard, A., action of electrolysis upon benzol, 95
distillation of colophonium, 209
Rennie, E. H., double salts of meconic acid, 75
Research Fund, Chemical Society, 23, 29
Resin of Palisander wood, 166
Reynolds, J. E., atomic weight of beryllium, 273
Righi, A., discharge in a rarefied medium, 183
Rinderpest, etiology of, 83
Robbs, C. E., bismuth and bismuth compounds, 242
Roberts, W. C., introductory lecture at the Royal School of Mines, 254, 263
Rocques, X., perforation of zinc cisterns and corrosion of lead pipes by water, 246
Rœser, Dr., lead and its salts with regard to health, 247
Rood, Prof., use of the term "indigo" by Newton, 37
Rosenstiehl, A., analogous colouring matters, 166
Rossler, G., melting-point of organic bodies, 36
Roth, C., colorimetric determination of chlorine in potassium bromide, 283
Rottenstein, J. B., "Surgical Anæsthesia" (review), 183
Rouge Francais, 108
Roux, M., L. Pasteur, and M. Chamberland, etiology of carbuncular disease, 225
Royal Institution of Great Britain, 235, 319
Royal Society, 283
Rubidium-thallium chloride, 175
Ruffle, J., estimation of nitrogen by combustion, 313
Rügheimer, L., and A. Ladenburg, artificial formation of tropic acid, 110
Russell, W. J., Chemical Society Research Fund, 23
Russian Chemical Society, 72, 234
Rye, manurial experiments on, 95

SABATIER, P., thermic researches on the ammonium polysulphides, 60
thermic study of the alkaline polysulphides, 48
Saccharification, new process of, 222
Saccharine, 318
matters contained in coffee, 258
Saffron, adulterations of, 259
Sahara, north of the, atmospheric electricity observed in, 210
Sainte-Claire Deville, M., and M. Troost, vapour densities of selenium and tellurium, 83
Salicylic acid, action of woody fibre upon, 120
antiseptic action of, 97
destructive action of woody fibre upon, 223
in wine and fruit juices, 48
new reaction for, 49
Salireton, 36
Salkowski, E., action of cane-sugar on silver oxide, 260
Salleron, J., modifications undergone by glass, 270
"Salt, Tables for the Analysis of a Simple" (review), 207
Salts, decomposition of by liquids, 222
in their solutions, influence of temperature on the distribution of, 165
haloid, oxidation of, 120
isomorphous, and fractional crystallisation, 304
part played by time in the formation of, 234
Salzor, T., behaviour of carbonic acid with Nessler's reagent and ammonia, 259
Saponificaton of fats, 317
Sarran, M., and M. Vieille, formation heat of gun-cotton, 282
Scacchi, A., yellow incrustation of the lava of Vesuvius of 1631, 37
Scandium, atomic weight of, 83
brilliant spectral rays of the metal, 60
Scherer, S., and L. Medicus, estimation of butter, 306
Scheurer-Kestner, M., solution of platinum in sulphuric acid, 61
Schiff, U., colouring bases derived from furfurol, 247
digallic acid, 36
formation of glucosides of a complicated structure, 259
Schizo-mycetes, action of products of putrefaction upon, 84
Schlœsing, T., constancy of the proportion of carbonic acid in the air, 24
Schmitz, A., wines mixed with grape-sugar, 318
Schmidt, E., daturine, 109
H., recognition of human and animal blood, 307
Schönn, J. L., ultra-violet rays, 186, 258
School of Mines, Royal, introductory lecture at the, 254, 263
Schools of Chemistry, 136, 166, 176
Schott, O., lithium glass, 36
Schrader, E., analysis of certain beers, 306
Schrœder, J., injury to vegetation from acid gases, 36
Schubler, C., vanilline in raw beet-root sugars, 109
Schucht, L., contribution to electrolysis, 331
Schüler, J., cobalti-cyanide compounds, 185
Schultz, A., antiseptic action of salicylic acid, 97
H., new reaction for salicylic acid, 49
Schulze, H., oxidation of haloid salts, 120
Schunck, E., modified chlorophyll from the Eucalyptus globulus, 31
Schützenberger, P., and N. Tonine, composition of the petroleum of the Caucasus, 305
Science and Art Department Examinations, 135, 166, 176
Science Classes, City Technical, 176
"Science Lectures delivered in Manchester, 1879-80" (review), 46
Science National Academy of New York, 291
Scott, M., effects of magnesia on vegetation, 213
"Sea-Sickness, Practical Treatise on" (review), 45
Seidler, G. P., cyanamide, 36
Selenium and tellurium, vapour densities of, 83
for baking stained glass, application of, 270
new, electric property of, 329
"Separation mud" as manure, 84
Sestini, F., physico-chemical analysis of arable soils, 247
ulmic materials produced by the action of acids upon sugar, 271
Sheep's feet, oil of, 166
Shimer, P. W., and T. N. Drown, determination of silicon and titanium in pig-iron and steel, 299
Shoddy and wool waste, analysis of, 325
Siemens-Martin steel, note on, 287
Siemens type, improvements in coils of the, 60
Silica, fixation of colours by, 49
Silicon and titanium, determination of in pig-iron and steel 299
determination of in iron and steel, 331
Silk and cotton, analysis of mixed tissues, &c., 73
Silver and gold, cupelling of, 27
determination of in alloys, 331
electrolytic determination of, 76
oxide, action of cane-sugar on, 260
sulphate, 163
Skraup, H., cinchomeronic acid, 186
synthesis of chinoline, 211
Smit, J. A. R., diamond mine in South Africa, 85
Smith, A. P., tin in preserved fruits, 34
J. D., thalleioquin test, 183
J. L., new meteoric mineral, 35
Dr. R. A., history of the word chemistry, 68, 244
reply to Dr. Leeds's criticism, 155

"Smithsonian Report" (review), 208
Soaps, analysis of, 53
Society, American Chemical, 21, 44, 58, 207, 246, 291, 304
Chemical, 29, 90, 241, 267, 287, 313
Manchester Literary and Philosophical, 31, 56, 68, 218, 244, 289, 303
of Arts, 235
of Glasgow, Philosophical, 281, 314
of Industrial Chemists, 234
of Mulhouse, Industrial, 165
Newcastle Chemical, 277
Physical, 9, 268, 277, 302
Royal, 283
Russian Chemical, 72, 234
Soda, manufacture of sulphate of, 322
Sodium and bromine, volumes of at their boiling-points, 287
and potassium, aluminates of in solution, 29
chloride, removal of large quantities of in mineral analyses, 305
hypobromite, determination of urea by, 166
hyposulphite and sulphuretted hydrogen, reaction between, 185
phosphate, use of in dyeing, 330
salts, boro-deci-tungstic acid and its, 210, 221
Soils, arable, physico-chemical analysis of, 247
Solar heat, utilisation of, 209
spectrum, distribution of light in the, 234
group of rays in the, 197
measure of the intensity of certain dark rays of, 200
telluric rays of the, 222
Solid fats, specific gravity of, 307
Sorby, H. C., address to British Association, 167
Soret, C., influence of temperature on the distribution of salts in their solutions, 165
J. L., absorption-spectra of the metals forming part of the groups of yttria and cerite, 198
[illegible]iran, J. L., insalubrity of [illegible]merican pork, 318
[illegible] London School of Phar[illegible]acy, 307
[illegible]ly, E. R., soft and hard [illegible]ater in brewing, 36
[illegible]et, Dr., behaviour of sugars [illegible]ith alkaline solutions of [illegible]pper and mercury, 96
[illegible]ic gravity of solid fats, 307
[illegible]ts at a constant volume in [illegible]imple and compound bodies, [illegible]2
[illegible]otatory power of cane- and invert-sugar, 177, 196, 208, 221, 233, 257, 269, 328
volume of chloral, 288
Spectra of ytterbium and erbium, 184
Spectral rays of the metal scandium, brilliant, 60
Spectroscopic examination of thulium, 197
studies of the sun, 258
Spectrum, solar, group of rays in the, 197
measure of the intensity of certain dark rays of the, 200
Spiller, J., identification of the coal-tar colours, 191
"Spirit-gravities" (review) 208
"Spirit of Nature" (review), 46
Splenic fever, nature of the immunity of Algerian sheep from, 60
Spring, water from a hot, 324
waters, zinc in, 49
"Stali-test" in the supervision of milk, 96
Stannous chloride, behaviour of with potassium chlorate, 210
peculiar reaction of with potassium chlorate, 166
Starch and dextrin, detection of, 311
Starch and glycogen, transformations of by diastase, 95
sugar, detection of honey sophisticated with, 271
mixed with cane-sugar, detecting, 305, 326
Staveley, W. W., fractional distillation of benzol, 183
Ste.-Claire Deville, odours of Paris, 22[illegible]
Stebbins, J. H., action of benzotrichloride on primary amines, 7
diazo-colours, 197
(junr.), new colouring-matters, 304
Steel and iron, determination of silicon in, 331
estimation of chromium in, 285
and pig-iron, determination of silicon and titanium in, 299
condition of carbon in, 131
note on Siemens-Martin, 287
varying condition of carbon in, 88
Steffens, H., iodine in Curacao guano, 42
Steiner, J., specific rotatory power of cane- and invert-sugar, 257
Stereocaulon Vesuvianum, chemical constituents of, 271
Stevenson, T., "Spirit-gravities" (review), 208
Stoddart, J. E., desilverisation of lead by the zinc process, 281
Stolba, F., chloraluminium used at cloth works, 210
Stolnikow, M., consequence of irritation of the liver by the electric current, 186
Strong's water-gas system, 27
Students, address to, 133
Stutzer, A., protein bodies, 103
Suguira, S., and H. Baker, magnesium vanadiates, 85
Sulphate, new aluminium, 23
of soda crystals, presence of copper in, 241
manufacture of, 322
silver, 163
volumetric determination of quinine, 318
Sulphates, molecular heats and volumes of the rare earths and their, 119
Sulphide, researches on nitrogen, 317
Sulphides of vanadium, 242
use of bromine in the analysis of, 259
Sulpho-cyanide, platinum, 166
Sulpho-groups, diazo-colours with more than two, 60, 72, 197
Sulphonic acid, nitroso-naphthol, 175
Sulphur, determination of in iron pyrites, 317
formation-heat of the oxides of nitrogen and those of, 35
presence of in illuminating gas, 303
lyes, technical analysis and valuation of Mond's, 97
Sulphuretted derivatives of diphenyl, 110
hydrogen and sodium, hyposulphite reaction between, 185
"Sulphuric Acid and Alkali, Manufacture of" (review), 212
Sulphuric acid after refining petroleum, removal of last traces of, 186
concentrated, action of on lead, 314
etherification of, 83
manufacture of, 85
solution of platinum in, 61
anhydride, evaporation heat of, 47
ether, neutral, preparation of, 13
Sun, application of the photophone to the study of the, 270
spectroscopic studies of, 258
Superphosphates, analysis of, 329
proportion of water in, 259, 260
"Surgical Anæsthesia," (review), 183
Swan, J. W., Address to the Newcastle Chemical Society, 277
electric lighting, 227

TANNIN in wines, 84
standard solutions of, action of light and darkness on, 44
used in Japan, materials containing, 274
Tanret, C., waldivine, 329
Tar, animal, 186
distillers' *v.* gas-companies', 12
Tartar and tartaric acid in must and wine, 84
Tartaric acid, free, in wines, 95
Tea, determination of theine in, 259
Technical museums and libraries, 307
science classes, city, 176
Telephone with magnetic super-excitation, 12
Telephonic effects from the shock of magnetic bodies, 83
Telluric rays of the solar spectrum, 222
Tellurium and selenium, vapour densities of, 83
atomic weight of, 84
Temperature, calorimetric determination of, 120
Terquem, A., modification in the Bunsen lamp, &c., 35
Terreil, A., phytolaccic acid, 317
and A. Wolff, resin of palisander wood, 166
Teubner, E., detection of small quantities of mercury, 307
Textile fabrics, weighing, 97
Thalén, R., brilliant spectral rays of the metal scandium, 60
spectra of ytterbium and erbium, 184
spectroscopic examination of thulium, 197
Thalleioquin test, the, 107, 183, 329
Theine in tea, determination of, 259
Thermic equilibrium of chemical actions, 258, 259
rays at low temperatures, wavelengths of the, 47
researches on the ammonium polysulphides, 60
study of the alkaline polysulphides, 48
Thermo-chemical researches, 120
Thermometer, air, new, 258
Thermometers, cause of variation in the fixed points of, 197
mercurial, rise of the zero-point in, 165
Thermometric questions, 222
Thiercelin, Dr, preparation of ashes for extracting iodine from sea-weeds, 282
Thollon, L., group of rays in the solar spectrum, 197
spectroscopic studies of the sun, 258
telluric rays of the solar spectrum, 222
Thomsen, J., thermo-chemical researches, 120
Thomson, W., chemical composition of ink on letters, &c., 32
Thulium, 185
spectroscopic examination of, 197
Tidy, C. M., composition and quality of the Metropolitan waters, 211, 319
Tiemann, F., aromatic amido-acids, 110
Tin in preserved fruits, 34, 47
Titanium and silicon in pig-iron and steel, determination of, 299
Titanium tetrachloride and acetyle chloride, a compound of, 166
Tobacco, combustibility of certain kinds of, 96
Tokio, University of, 59
Tommasi, D., isomeric modification of aluminium hydroxide, 119
thermic equilibrium of chemical actions, 258, 259
Tonine, N., and P. Schutzenberger, composition of the p troleum of the Caucasus, 305
Topography of chemical processes in the animal system, 186
Trécul, A., lightning ascending vertically, 209
Trefriw mineral water, 176
Trève, M., certain optical and visual phenomena, 329
Tribe, A., and J. H. Gladstone, aluminium alcohols, 267
aluminium-iodine reaction, 2
Triple-action apparatus, incrustations formed in, 247
Troost, L., density of the vapour of iodine, 60
and M. Ste.-Claire Deville, vapour-densities of selenium and tellurium, 83
Tropic acid, artificial formation of, 110
Tropidine, 108
Trouvé, G., improvements in coils of the Siemens type, 60
new electric motor, 330
Tungstoboric acid, 209
Tussah silk bleaching, 49

ULEX, Dr., arsenophobia, 36
Ulmic materials produced by the action of acids upon sugar, 271
Ultramarine compounds, certain, 24
constitution of, 204, 291
Ultra-violet rays, 186
University Laboratory of Halle, 96
of Tokio, 59
Universities and Colleges, 133
Uranium, certain fluorised compounds of with the alkaline metals, 95
fluorine compounds of, 83
Urea, determination of, 186
by sodium hypobromite, 166
Urine, detecting albumen in, 210
Ultra-violet rays, 258

VANADIATES, magnesium, 85
Vanadium, fluorine compounds of, 85
in commercial caustic soda, 185
sulphides of, 242
Vanilline in raw beet-root sugars, 109
Vapours, critical-point of mixed, 15
Varenne, E., and L. Prunier, products contained in the coke of petroleum, 282
Varrentrapp and Will's process for the determination of nitrogen, 49
Vaugel, B., action of dehydrating agents upon acids, 109
Vautelet, E., disinfection and preservation for agricultural purposes, 24
Vegetation, effects of magnesia on, 213
injury to from acid gases, 36
Vesuvius, lava of 1631, yellow incrustations of, 37
Vieille and Sarrau, MM., formation heat of gun-cotton, 282
Villiers, A., etherification of hydriodic and hydrochloric acids, 48
hydrobromic acid, 35
sulphuric acid, 83
the hydracids, 61
preparation of neutral sulphuric ether, 13
Vinegar, manufacture of by means of bacteria, 165

Vinification, utility of boric acid in, 259
Vinter, A., "Analysis of a Simple Salt for Use in School Laboratories" (review), 207
Virginia, chemistry in the University of, 180, 193
Virulent diseases, 4
Visual and optical phenomena, certain, 329
Volatile ignition, tubulated crucible for estimating, 326
Vollbrecht, D., H. Albert, and H. Joulie, behaviour of phosphoric acid in the soil, 35
Volumetric determination of lead, 89
indicator, eupittonic acid as a, 36
Von Babo, C., C. Portele, and E. Mach, tartar and tartaric acid in must and wines, 84
Von der Becke, Dr., saponification of fats, 317
Von Eder, J. M., photo-chemistry of silver, 186
Von Lepel, F., behaviour of the juices of fruits of different ages with reagents, 48
Von Mering, J., E. H. Bimmermann, and F. Musculus, transformations of starch and glycogen by diastase, 95
Von Miller, W., rouge Francaise, 108
Von Rechenberg, C., combustion-heat of organic compounds, 222
Von Spitzer, F., chlorides of camphor, 210
Von Wolff, E., "separation-mud" as manure, 84
Vorak, V. D., simple method of observing diffraction, 258

WACHTER, H., and J. Nessler, free tartaric acid in wine, 95
Waldivine, 329
War powder, transformation of in the metal cartridge boxes of the infantry, 23
Warden, C. J. H., analysis of forage biscuits, 287
Wartha, A., method for determining the temporary hardness of water, 271
Water and fire-proof paper, 330
Bunsen's method for determining free oxygen in, 206, 221
from a hot spring, 324
from peat moors and alder swamps, injurious effect of upon meadows, 84
gas system, Strong's, 27
lowering the freezing-point of by pressure, 1
method of determining the temporary hardness of, 271
microscopical examination of, 85
perforation of zinc cisterns by, 246
proof, new means of rendering tissues, 330
proportion of in superphosphates, 259, 260
soft and hard, in brewing, 36
solution of chlorine in, 119
Waters, ammonia in the air and in the, 83
composition and quality of the metropolitan, 211, 319
zinc in spring, 49
"Washington Philosophical Society, Bulletin" (review), 182
Watson, W. H., action of oils on metals, 190
Watt, A., specific rotatory power of cane- and invert-sugar, 196, 221
Wave-lengths of the thermic rays at low temperatures, 47
Weber, L., remarks on Mr. Crookes's experiments, 258
Weidel, H., and G. L. Ciamician, animal tar, 186
behaviour of bone glue on dry distillation, 175
Weigert, L., detection of salicylic acid in wine and fruit juices, 48
Wein, E., condensed milk, 96
cultivation of the yellow lupin, 95
fatty acids of butter, 72
Weiss, G., remarks on Mr. Tatlock's letter, 259
Weldon mud, 10, 19, 97, 246
W., relation between the atomic volumes of certain elements, 171
Weldon mud, 10, 246
Wernich, M., action of the products of putrefaction upon schizomycetes, 84
Weyl, T., and M. Bischoff, gluten, 109
Will and Varrentrap's process for the determination of nitrogen, 49
"Wills, T., F.C.S., Life of" (review), 59
Wills, W. L., atomic weight of tellurium, 84
Winckler, C., disposal of furnace smoke, 85
Wine and fruit juices, detection of salicylic acid in, 48
phosphoric acid in, 85
Wines, aldulteration of, 37
ash in, 49
mixed with grape-sugar, 318
tannin in, 84
Wishart, G. J., tin in preserved fruits, 47
Witt, O. N., constitution of so-called nitrous vapours 185
Wleugel, S., indium in Norwegian minerals, 85
Wolff, A., and A. Terreil, resin of palisander wood, 166
Wollny, E., commercial value of grain, 35
Woody fibre upon salicylic acid, action of, 120
destructive action of, 223
Wool waste and shoddy, analysis of, 325
Wright, C. R. A., chemical affinity in terms of electromotive force, 302
measurement of chemical affinity, 249
Wurtz, A., papaine, 24, 294
Würzburg University, communications from the laboratory of, 13, 24
Wyrouboff, G., platinum sulphocyanide, 166

YARDLEY, H. B., agitation of liquids, 13
washing flask, 13
Yellow lupin, cultivation of, 95
Yttria and cerite, absorption spectra of the metals forming part of the groups of, 193
Ytterbium, atomic weight of, 61
and erbium, spectra of, 184

ZELLER, C. F., the thalleioquin test, 107, 329
Zero-point in mercurial thermometer, rise of, 165
Zinc chloride as a reagent for alkaloids, &c., 318
cisterns, perforation of by water, 246
dust, decomposition of simple organic compounds by, 210
ethyl on benzoylic cyanide, action of, 242
in spring water, 49
metallurgical, treatment of complex ores containing, 201
oxide in alkaline solutions, 30
powder, determining the value of, 48
process, desilverisation of lead by the, 281
Züblin, H., and V. Meyer, platinum bromide, 120
Zulkowsky, C., crystalline constituents of coralline, 84

END OF VOLUME XLII.

P
Chem.
& Phys.
C

47804

Chemical News.
Vol. 41-42, 1880.

DATE.

University of Toronto
Library

DO NOT
REMOVE
THE
CARD
FROM
THIS
POCKET

STORAGE

Acme Library Card Pocket
Under Pat. "Ref. Index File"
Made by LIBRARY BUREAU